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Peter Turchin, Leonid Grinin,
Andrey Korotayev, and
Victor C. de Munck

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The times of "Pure History" when historians were only interested in the deeds of kings and heroes passed long ago. A more and more important role is played by new directions in historical research that study long-term dynamic processes and quantitative changes. This kind of history can hardly develop without the application of mathematical methods.

This almanac continues a series of edited volumes dedicated to various aspects of the application of mathematical methods to the study of history and society. This edited volume considers historical dynamics and development of complex societies. Its constituent articles treat historical processes at very different levels of scale. Some articles study global dynamics during the last millennia covering the formation and development of the World System. Other articles focus on the dynamics of single societies, or even communities. In general, this issue of the almanac constitutes an integrated study of a number of important historical processes through the application of various mathematical methods. In particular, these articles trace the trajectories of political development from the early states to mature statehood. This almanac also traces trajectories of urban development, and important demographic, technological, and sociostructural changes.

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Introduction.
Why do we need mathematical models of historical processes

Peter Turchin, Leonid Grinin, Andrey Korotayev

Many historical processes are dynamic (a *dynamic* process is one that changes with time). Populations increase and decline, economies expand and contract, while states grow and collapse. How can we study mechanisms that bring about temporal change and explain the observed trajectories? A very common approach, which has proved its worth in innumerable applications (particularly, but not exclusively, in the natural sciences), consists of taking a holistic phenomenon and mentally splitting it up into separate parts that are assumed to interact with each other. This is the dynamical systems approach, because the whole phenomenon is represented as a system consisting of several interacting elements (or subsystems).

In the dynamical system's approach, we must describe mathematically how different subsystems interact with each other. This mathematical description is the model of the system, and we can use a variety of methods to study the dynamics predicted by the model, as well as attempt to test the model by comparing its predictions with the observed dynamics.

Generally speaking, models are simplified descriptions of reality that strip away all of its complexity except for a few features thought to be critical to the understanding of the phenomenon under study. Mathematical models are such descriptions translated into a very precise language which, unlike natural human languages, does not allow for any double (or triple) meanings. The great strength of mathematics is that, once we have framed a problem in mathematical language, we can deduce precisely what are the consequences of the assumptions we made – no more, no less. Mathematics, thus, is an indispensable tool in true science; a branch of science can lay a claim to theoretical maturity only after it has developed a body of mathematical theory, which typically consists of an interrelated set of specific, narrowly-focused models.

The conceptual representation of any holistic phenomenon as interacting subsystems is always to some degree artificial. This artificiality, by itself, cannot be an argument against any particular model of the system. All models simplify the reality. The value of any model should be judged only against alternatives, taking into account how well each model predicts data, how parsimonious the model is, and how much violence its assumptions do to reality. It is important to remember that there are many examples of very useful models in nat-

ural sciences whose assumptions are known to be wrong. In fact, all models are by definition wrong, and this should not be held against them.

Mathematical models are particularly important in the study of dynamics, because dynamic phenomena are typically characterized by nonlinear feedbacks, often acting with various time lags. Informal verbal models are adequate for generating predictions in cases where assumed mechanisms act in a linear and additive fashion (as in trend extrapolation), but they can be very misleading when we deal with a system characterized by nonlinearities and lags. In general, nonlinear dynamical systems have a much wider spectrum of behaviors than could be imagined by informal reasoning. Thus, a formal mathematical apparatus is indispensable when we wish to rigorously connect the set of assumptions about the system to predictions about its dynamic behavior.

Modeling of any particular empirical system is as much art as science. Models can be used for a variety of purposes: a compact description of the system structure, an investigation into the logical coherence of the proposed explanation, and derivation of specific predictions from theory that can be tested with data. Depending on the purpose, we can develop different models for the same empirical system.

There are several heuristic rules that aid development of useful models. One rule is: do not attempt to encompass in your model more than two hierarchical levels. A model that violates this rule is the one that attempts to model the dynamics of both interacting subsystems within the system *and* interactions of subsubsystems within each subsystem. For example, using an individual-based simulation to model interstate dynamics violates this rule (unless, perhaps, we model extremely simple societies). From the practical point of view, even powerful computers take a long time to simulate systems with millions of agents. More importantly, from the conceptual point of view it is very difficult to interpret the results of such a multilevel simulation. Practice shows that questions involving multilevel systems should be approached by separating the issues relevant to each level, or rather pair of levels (the lower level provides mechanisms, one level up is where we observe patterns).

The second general rule is to strive for parsimony. Probably the best definition of parsimony was given by Einstein, who said that a model should be as simple as possible, but no simpler than that. It is very tempting to include in the model everything we know about the studied system. Experience shows, again and again, that such an approach is self-defeating.

Model construction, thus, always requires making simplifying assumptions. Surprisingly, however, the resultant models are often quite robust with respect to these initial assumptions. That is, "first-cut" models can be investigated mathematically as to the consequences of relaxing the initial assumptions for theoretical predictions. Repeated applications of this process can extend theory and simultaneously increase confidence in the answers that it provides. The end result is an interlocked set of models, together with data used to estimate model parameters and test model predictions. Once a critical mass of models and data

has been accumulated, the scientific discipline can be thought of as having matured (however, it does not mean that all questions have been answered).

The hard part of theory building is choosing the mechanisms that will be modeled, making assumptions about how different subsystems interact, choosing functional forms, and estimating parameters. Once all that work is done, obtaining model predictions is conceptually straightforward, although technical, laborious, and time consuming. For simpler models, we may have analytical solutions available. However, once the model reaches even a medium level of complexity we typically must use a second method: solving it numerically on the computer. A third approach is to use agent-based simulations. These ways of obtaining model predictions should not be considered as strict alternatives. On the contrary, a mature theory employs all three approaches synergistically.

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One of the main causes for the expansion of the application of formal mathematical methods to the study of history and society is the deep changes that have taken place during recent decades in the field of information production, collection, and processing (as well as in the field of information technologies, in general). These changes affect more and more fields of academic research. The enhanced possibilities for the development of databases, the increasing speed of their processing, in conjunction with the growing availability of many forms of digital information, the diffusion of personal computers and more and more sophisticated software provide all the grounds needed to forecast not only the expansion for the formalization of new methods of information processing and presentation, but also the expanding application of formal mathematical methods in such fields that seem to have nothing to do with mathematics. We may note some serious changes in the attitudes of the "humanitarians" toward formal mathematical methods. The application of formal mathematical methods in the humanities is not just a fashion, or the way to make one's research faster and more comfortable. It becomes evident that such methods create necessary conditions for intellectual breakthroughs, for the establishment of new paradigms, for the discovery of new research directions. To a considerable extent this is accounted for by the very character of many historical processes.

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[1] For more detail see Grinin, de Munck, and Korotayev 2006; Borodkin, Thaller, and Turner 1995; Turchin 2003, 2005a, 2005b; Turchin and Korotayev 2006; Nefedov 2004; Гринин, Коротаев, Малков 2006; Малков, Гринин, Коротаев 2006; Коротаев, Малков, Гринин 2006; Малинецкий 1996, 1998, 2004; Малков 2004; Чернавский 2004.

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Scientific Prediction in Historical Sociology: Ibn Khaldun meets Al Saud

Peter Turchin

One of the hallmarks of a mature discipline is its ability to make predictions that can be used to test scientific theories. Scientific predictions do not necessarily have to be concerned with future events; they can be made about what occurred in the past. I illustrate such retrospective prediction with a case study of conversion to Christianity in the Roman Empire. The bulk of the paper deals with the logic and methodology of setting up a scientific prediction in macrosociology. The specific case study I develop is the possible state collapse in Saudi Arabia. The theoretical setting is provided by the demographic-structural theory of state collapse. The starting point is a previously developed model for political cycles in agrarian societies with nomadic elites, loosely based on the ideas of Ibn Khaldun. I modify the model to fit the characteristics of the modern Saudi Arabian state and estimate its parameters using data from published sources. The model predicts that the sovereign debt of Saudi Arabia will eventually reach unmanageable proportions; the fiscal collapse will be followed by a state collapse in short order. The timing of the collapse is affected by exogenous events (primarily, fluctuations in world oil prices) and by parameter uncertainty (certain parameters of the model can be estimated only very approximately). The generalized prediction of eventual Saudi collapse together with subsidiary relationships specifying how variations in exogenous factors and parameters affect the future trajectory is the "Ibn Khaldun scenario." A major theoretical alternative is provided by a set of ideas and specific recommendations suggesting how Saudi Arabia can avoid crisis by reforming its economy and liberalizing its political system (the "IMF scenario"). The main purpose of the proposed test, therefore, is to determine which of the two theoretical scenarios will best describe the trajectory of the Saudi state over the next decades.

INTRODUCTION: Scientific prediction

The ability of a discipline to make valid predictions is a sign of its maturity (Collins 1995: 1588). As historical sociology matures, its practitioners have begun to wrestle with the question of prediction. A good illustration of this preoccupation is the Symposium on Prediction in the Social Sciences at the 1993 meeting of the American Sociological Association (see Hechter 1995). The participants and commentators of the symposium expressed a wide range of opinions on the possibility of predicting such macrosociological phenomena as revolutions, ranging from "it cannot be done" to "it already has been done" (Kiser 1995). This disagreement is due, in large part, to differing definitions used by the authors. Thus, the first order of business is to clarify the various meanings of the word "prediction".

The usual meaning of "prediction" is a statement that a certain kind of event will occur at some future time. What distinguishes prediction in science from the common usage is that we must have an explicit scientific theory on which the prediction is based. This requirement leaves beyond the pale "predictions" propounded by pundits at TV talk shows (no explicit theory) or astrological predictions (the underlying "theory" is unscientific). Within the scientific usage, we can further distinguish three kinds of predictions. The first, and conceptually the simplest one, is *projection*. In a projection exercise we ask a "what if" question: assuming certain initial conditions and a certain mechanism of change, what would be the future trajectory of the modeled system? An example is demographic projections that we can run for different scenarios of future fertility changes in the US. Whether the total fertility rate stays constant, declines, or increases will have a strong effect on the future age structure of the US population (*e.g.*, Lee and Tuljapurkar 2001).

A *forecast* is a prediction that a certain variable will reach a specified level (or will be within the specified range of values) at a certain point in the future. Unlike the projection exercise, forecasting requires that we accept the validity of the assumptions of the underlying theory. A common example of a forecast is the weatherman on the TV predicting that the temperature will be between 70 and 75 degrees F at noon two days hence. Forecasts are made for a variety of practical reasons usually having nothing to do with science.

The third kind of prediction (I will call it *scientific prediction* to distinguish from the others) is used to test scientific theories. Scientific prediction inverses the logic of forecasting: whereas in making forecasts we assume the validity of the underlying theory and want to know what will happen to observables, in a scientific prediction exercise we want to use the observables to infer the validity of the theory. We take it for granted that theories yielding predictions that are in good agreement with empirical patterns are preferable to those who make poor predictions. The distinction I make here between forecasts and scientific predictions roughly parallels the distinction between unconditional historical prophecies and (also) scientific predictions, made by Karl Popper and endorsed by Michael Hechter (1995: 1522).

I would argue that it is scientific predictions, rather than forecasts (and especially projections), that are the hallmark of a mature science. Why should macrosociologists care about forecasts? No practical person (*e.g.*, a politician, or an intelligence analyst) should pay any attention to forecasts made by sociologists about, for example, the possibility of revolution in any particular state. At present time historical sociologists are only beginning to understand the causes of revolution and state collapse. Certainly, we are not at the stage where meaningful forecasts are possible. In other words, making forecasts is a useless activity given the current state of development of historical sociology. On the other hand, making scientific predictions could be a very fruitful activity, because the end result may be precisely what we currently lack – understanding. At least, that's how it worked in natural sciences, and there is no reason to as-

sume that it will be impossible to repeat this feat in social sciences (Turchin 2003).[1]

Another strike against forecasts is that many mature sciences lack the ability to make accurate forecasts. Taking again the weather prediction, it is well known that no meaningful weather forecasts can be made farther in the future than 7−10 days. The reason is that the dynamical system governing fluctuations in temperature, pressure, and rainfall (which we call "weather") is characterized by sensitive dependence on initial conditions (popularly known as chaos). The characteristic time of trajectory divergence is such that very similar initial conditions, well within the observation error of the global network of weather stations, can and do produce completely different outcomes after just 7−10 days. Although we cannot make long-term weather forecasts, the science underlying weather fluctuations (a discipline of physics known as fluid dynamics) is completely understood. Thus we have a seemingly paradoxical situation where the scientific understanding of processes is highly mature while our ability to predict long-term dynamics is nonexistent.

How should we use scientific prediction in macrosociology? Actually, setting it up is not a trivial task (which is why the ability to make scientific predictions is a sign of maturity in a discipline). The main requirement, of course, is a well-developed and sufficiently formalized theory from which to derive testable predictions. Ideally, the theory should be formulated in mathematical language, which makes it hard to sneak in hidden assumptions. Even more importantly, mathematical formalization increases the potential for quantitative predictions, which have a greater falsifiability potential.[2] This consideration leads us to one thorny problem in scientific prediction, how to judge whether the theoretical statement to be tested has a high falsifiability potential, that is, whether it is *novel* (Elman and Elman 2003). Should I, for example, use any theory to make a prediction that the US will not have a state collapse during the next month, and then observe that, indeed, this is what happened, the reaction will be deservedly underwhelming. A successful, but trivial prediction should not have any confirmation value. But how do we judge which predictions are trivial and which are novel? The solution is simple: we should never test a theory in isolation, but always against alternatives. The simplest alternative could be a "null hypothesis," an expectation that future events occur entirely at ran-

[1] A lively discussion on the methods of explanation in historical sociology has developed during the 1990s (Kiser and Hechter 1991, Somers 1998, Kiser and Hechter 1998, Steinmetz 1998). In this paper I do not need to choose sides in this largely philosophical and highly abstract debate. My intent, rather, is to construct a specific and concrete case-study in scientific prediction, leaving the philosophical issues to philosophers.

[2] An example of qualitative prediction is "societies of type *A* are less susceptible to collapse than societies of type *B*." Even if the theory making this prediction is wrong, that is, the type of society has nothing to do with its susceptibility to collapse, there is still a 50% chance that the prediction itself turns out to be true, because there are only two possible outcomes of the test (*A*s are either less or more susceptible to collapse than *B*s). As a result, qualitative predictions tend to have a low falsifiability potential.

dom. A better alternative is some sort of formalization of "common sense." However, ideally we would like to be in a position to test our theory against a fully developed alternative theory, or theories (this is described more fully in Turchin 2003:7-8). Having two (or more) explicit theories allows us to determine for what aspects of reality their predictions coincide and, more importantly, where they disagree. Then, we collect data on the aspect where the theories disagree. The confirmation status of the theory, whose prediction matches the data better, is elevated, while the unsuccessful theory's status is degraded (and eventually, after it makes a lot of poor predictions, we might decide to call it "rejected"). Thus, a well-designed exercise in scientific prediction can be defined as a planned comparison between two (or more) scientific theories using the data as arbiter.[3] We now see that scientific prediction is a technically and conceptually much more difficult exercise than "mere" forecasting. Essentially, we must obtain multiple forecasts, from each of the theories we are testing. Furthermore, it may be necessary to run multiple projections to test the effects of assumptions (this will be illustrated below for the Al Saud prediction).

To sum up, in contrast to forecasts (as defined here), which are useless to the scientific progress, each successful exercise in scientific prediction advances our understanding of the processes involved. It is the ability to make scientific predictions that is a hallmark of maturity in a scientific discipline. It means that the discipline has accumulated enough theoretical models to erect explicit alternative hypotheses, and that it has developed structures for translating the chaos of raw sensory inputs into *data*, formalized empirical observations that can be used in testing theories ("normalized data" and "relevant facts" in the formulation of Rozov 2000).

Retrospective prediction: an example

One important aspect of the definition of scientific prediction given above is that there is nothing in it about predicting the *future*. Logically it does not matter whether the empirical event (or events) that we use to distinguish among theoretical alternatives will take place in the future, or has already occurred. The importance of this aspect cannot be overemphasized, because if we had to wait for our scientific predictions to be fulfilled (or not), the progress in historical sociology would be very slow, or even impossible (how could we test sociological theories about agrarian empires, if there are no such polities left in the world?).

As an illustration of such retrospective prediction, or retrodiction (Kiser and Hechter 1991), consider the case of testing dynamical theories about religious

[3] It is important to note that a prediction exercise is not the only way that general propositions (theories) can be tested. Other ways include checks for logical coherence, verification of the postulated proximal mechanisms and processes of change, examinations of comparative evidence (Richerson and Boyd 2001), analytic narratives (Bates et al. 1998), and at least two kinds of experiment, manipulative and mensurative. A prediction exercise is essentially a mensurative experiment, and only one way of many to do good science.

conversion (Turchin 2003). Three more-or-less explicit models for religious conversion and ethnic assimilation have been proposed in the literature: the noninteractive, the autocatalytic, and the threshold models. The justification for each of the model does not concern us here (the details are in Turchin 2003: Chapter 6); what is important is that each model predicts a qualitatively different trajectory (the proportion converted/assimilated as a function of time). This means that we can determine which theory better reflects the reality if we can find data on the temporal course of conversion. Empirical data on conversion to Islam in Iran and Spain, early Christianity in the Roman Empire, and the growth of Mormonism all strongly supported the autocatalytic model and were nothing like trajectories predicted by the two alternatives. What do we conclude from this result? All models are by definition wrong, because they oversimplify the complex reality, but the autocatalytic model is less wrong than the alternatives. We can tentatively conclude that the assumptions of the conversion process built into the autocatalytic model are approximately correct (at least, until an even better alternative model is proposed).

A critic might point out that the shape of the empirical conversion curves was already known to the tester prior to the test, and therefore the result of the test was a foregone conclusion. There is some validity in this criticism, so let us delve a bit into the issues involved. A good paradigm is provided by the distinction made in statistics between fitting models to data and using fitted models to *predict out-of-sample data* ("in-sample" refers to data used in model fitting, "out-of-sample" data are those that were not used in fitting but were reserved for testing the model; or perhaps were collected after the model was fitted). Indeed, flexible statistical models, given a sufficient number of parameters, can fit almost any imaginable shape. Thus, a true measure of how well a statistical model does at capturing certain aspects of reality can be obtained only by forcing it to predict out-of-sample data.

But the three conversion models that I considered were not flexible statistical models. They were based on specific assumptions about mechanisms underlying conversion, and predicted qualitatively different shapes of trajectories. Thus, the comparison between theoretically predicted shapes and the empirically observed ones was definitely a step forward, because it roundly rejected two of the models in favor of one. Nevertheless, the putative critic is partially correct because successfully predicting out-of-sample data should always carry more weight than predicting data already in hand.

Actually, there was an element of out-of-sample prediction in the test involving the early Christianity data. This case study came from the book by Rodney Stark (1996) on the rise of Christianity (see also Hopkins 1998, Stark 1998). Stark used a variant of the autocatalytic model to predict how the number of Christians in the Roman Empire grew from the first century on. He estimated (guessed, really) that there were roughly a thousand converts in 40 CE and that their numbers grew at the rate of 40% per decade. Several years after he made these estimates, a colleague attracted his attention to the reconstruction by Roger Bagnall of the growth of Christianity in Egypt, based on data in

Egyptian papyri. Since Stark was unaware of Bagnall's data at the time when he constructed his prediction, we have here a true test with out-of-sample data.

The story gets even better. Two years after I wrote the chapter on conversion in my book on Historical Dynamics I happened on a reference to a German dissertation that gave a list of Pagan and Christian office-holders between 324 and 455 (von Haehling 1978). I immediately realized that this data provide me with an opportunity to make another test of the theory. We can treat the Bagnall data as the "in-sample", on which the model parameters were fitted (and published prior to the knowledge of the von Haehling data). The von Haehling numbers, thus, are the "out-of-sample" data, on which the model's predictions are tested. The results are shown in Figure 1, where the predicted curve is calculated using the formula on p. 107 in Turchin (2003) and the parameter values as previously published: the initial proportion of the Roman population converted to Christianity at 40 CE, $\gamma = 0.0017\%$ (p. 111) and the relative growth rate, $r = 0.034\ \text{yr}^{-1}$ (Table 6.1).[4] We see that the curve fitted to the Bagnall data (showing the proportions converted before 300 CE) does a very good job predicting the course of Christianization in the von Haehling data (after 330 CE). The coefficient of prediction (the proportion of variance of out-of-sample data predicted by the model) is a very healthy 0.57. This is a remarkable result, given that the data are quite crude, affected by fairly large observation errors. We note that the predicted curve slightly overpredicts the data (5 data points above the curve compared to 10 points below). This is as should be expected – after all, the curve was not *fitted* to the data.

Why predict future?

I think that the above example illustrates very nicely that successful scientific retrodiction is possible and (more importantly) fruitful in historical sociology. Of course, a very suspicious critic might point out that there is a possibility of dishonesty on my part. Indeed, it is conceivable that I had the prior knowledge of the von Haehling data, and then craftily did not reveal it until my book came out, so I could claim to have made a successful out-of-sample prediction two years later. This is not what happened, but how could I prove it? This potential (if unfair) criticism, I think, reveals why predictions about future are usually considered as the strongest kind of test of theories – it precludes cheating. In my opinion, we tend to overestimate the value of predictions about the future, and we do it not for logical, but for psychological reasons. After all, retrodiction can also be set up to preclude any possibility of cheating. For example, one could use the theory to predict some data that have not yet been unearthed by archaeologists.

My argument above should not be taken as an exhortation to completely avoid predictions about future events (just that we should not limit ourselves to them). Under certain circumstances, such predictions can be set up to yield val-

[4] Note that r here stands not for the coefficient of correlation, but it is a parameter in the model.

uable tests of theories. One particular example that can be used in a prediction exercise is Saudi Arabia, to which I now turn. I begin by discussing the theory to be tested, which can ultimately be traced to Ibn Khaldun. Next, I propose an explicit model, based on the general theory but taking into account the peculiarities of the Saudi setup. Third, I consider empirical sources for the estimation of parameters. Finally, I return to the general issue of scientific prediction (as opposed to forecasting), and discuss how the Saudi Arabian exercise helps us to clarify the meaning and limitations of the approach.

AN EXPERIMENT OF SCIENTIFIC PREDICTION: State collapse in Saudi Arabia?

Theory: Ibn Khaldun

Abd al-Rahman Abu Zaid ibn Muhammad ibn Khaldun (1332−1406) was a statesman, jurist, and historian, and perhaps the first sociologist in the modern sense (Gellner 1981). He is best known for his remarkable theory of political cycles, based on his intimate knowledge of Islamic societies of the Maghrib (Northern Africa west of Egypt). Ibn Khaldun's theory can be extended (naturally, with many modifications) to apply to agrarian societies in general (this is discussed in Turchin 2003: Sections 3.2.1 and 7.1). The ideas of Ibn Khaldun, furthermore, can be synthetized with theories of state collapse proposed by modern sociologists (the main influence is the work of Jack Goldstone, see Goldstone 1991) to develop a general theory of state collapse in agrarian societies (Turchin 2003).

The core of the theory, as it is currently formulated (Turchin 2003: Chapter 7, following Goldstone I call it the demographic-structural theory), concerns the relationship between population growth and fiscal stability of the state. Briefly, population growth in excess of the productivity gains from the land leads to persistent inflation and rising real costs, which outstrip the ability of the state to increase tax revenues. Rapid expansion of population also results in an increased number of aspirants for elite positions, putting further fiscal strains on the state, and intensifying intra-elite competition and factionalism. Increased rural misery, urban migration, and falling real wages lead to frequent food riots and wage protests; expansion of youth cohorts contributes to the population mobilization potential; and elite competition and popular discontent fuel ideological conflicts. As all these trends intensify, the end result is state bankruptcy and consequent loss of military control; elite movements of regional and national rebellion; and a combination of elite-mobilized and popular uprisings that manifest the breakdown of central authority (Goldstone 1991:25).

This verbally formulated theory has been formalized by constructing a suite of mathematical models covering various combinations of assumptions about the structure of studied societies. Of main relevance to the topic of this paper is the model that was appropriately named "the Ibn Khaldun's model" (Turchin

2003: Section 7.2.3). Here I give an abbreviated description of the model, while in the next section we will see how it can be adapted to the case of modern Saudi Arabia.

The dynamics of the Ibn Khaldunian "world-system" are determined by the interaction between the civilized society and the desert tribes. The civilized region is the site of recurrent state building/collapse episodes. It is inhabited by indigenous commoner population, who provide the productive basis of the society. The desert is inhabited by stateless (but not chiefdomless) tribes, who periodically conquer the civilized region and establish a ruling dynasty there. Desert tribes, thus, supply the ruling elites for civilized states. Initially the ruling dynasty establishes government that is moderate in expenditures and just in administration. General prosperity results in population growth, and causes both rulers and people to become accustomed to increased spending ("luxury"). The army and bureaucracy demand and receive higher pay. As habits of luxury increase, and must be paid for, the state attempts to increase its revenue through heavy taxation, or outright seizure of its subjects' property. This fiscal policy inevitably leads to the ruin of economy, followed by famines, pestilence, political unrest, and eventually state collapse. The area then is reconquered by desert tribes, who establish a new dynasty and the cycle repeats.[5]

In the model I simplify the Ibn Khaldun scenario by focusing on just two components of the system: the state fiscal health and the elite dynamics (note that such drastic simplification is a key step in building successful models; I will discuss this issue in more detail in the next section). I assume that the dynamics of commoner population are largely disconnected from the elite dynamics. Dynasties come and go, but peasants and merchants continue to grow food, trade, and pay taxes to whichever government is currently in power. (This assumption, of course, greatly oversimplifies the reality, and thus I investigated an alternative formulation that models commoner dynamics explicitly, see Turchin 2003:134). Thus, the rate of resource extraction from commoners is a constant, *R*. During the early years of the dynasty, the extracted resources are divided in two parts: taxes to support the government, and rents to support the elites.

Elite dynamics are characterized by two variables: their numbers and average per capita income. One important parameter in the model is $\mu_{\min}$, the per capita income that nobles consider to be the minimum that accords with their station. This "minimal acceptable income" is determined socially, and can vary between societies. Ibn Khaldun argued that with time former tribesmen forget the rude ways of the desert, and subsequent generations grow accustomed to ever increasing luxury. Thus, $\mu_{\min}$ is a variable that starts at some low level at the beginning of the dynasty and then increases at a certain rate. Elite numbers

[5] A very important part of Ibn Khaldun's theory is how the *asabiya* (group solidarity) of the dynasty waxes and wanes during the cycle, but here I do not have space that discussion of this fascinating topic requires (see Inayatullah 1997, Turchin 2003: Chapter 3).

increase as long as their incomes exceed the minimum. I estimated the maximum (per capita) rate of increase, $r_{max} = 0.08\ yr^{-1}$ at four times the intrinsic rate of population increase typical for preindustrial populations.[6]

The key assumption of the model is that as long as income per elite capita, generated from rents, exceeds the minimum acceptable income, the state and elites live in harmony. However, if elite numbers grow to the point where their per capita incomes fall below μ_{min}, then nobles become dissatisfied, and will use a variety of techniques to divert some of the taxes into their pockets.

The state fiscal dynamics are modeled as the balance of revenues and expenditures. Revenues consist of a fixed proportion of *R* as long as elites are not too numerous. Eventually the numerical growth of nobility leads to the decline of state revenues. The expenditures are proportional to the elite numbers, because elites demand employment from the state as army officers, bureaucrats, and courtiers. Thus, the dynamics of *S*, the accumulated state resources, follows a typical trajectory through time. During the early period of the dynasty *S* grows, because elite numbers are few and their appetites are modest. At some point, however, the revenues drop to the point where they cannot match expenditures, and *S* declines, and eventually become 0. At this point, the model assumes that the dynasty failed: it is abandoned by the army and civil officials whom it can no longer pay. The state becomes vulnerable to conquest, which (at least in the model) happens immediately, because the desert tribes provide the ready and spatially adjacent source of the next dynasty. A typical trajectory predicted by the model is illustrated in Figure 2. Numerical investigation of the effect of parameter values on the dynamics of the Ibn Khaldun model indicated that the main parameters that affect the period of the cycle are the maximum rate of elite population increase (r_{max}) and the rate at which the minimal acceptable income grows with time. Rather rapid cycles of about one century in period, shown in Figure 2, obtain for high values of r_{max} that should be typical for societies where elite polygyny is widespread.

The test case: Al Saud

Modern Saudi Arabia, of course, differs in many important respects from the medieval Maghribian societies, which provided the inspiration for Ibn Khaldun's theory and the model described above. Surprisingly, however, we can tailor the model, described in the previous section, to the situation of Saudi Arabia without needing to add much complexity. Furthermore, as we shall see, the basic dynamics predicted by the model carry over to the modern case.

First, Saudi Arabia is not an agrarian society. However, it has a greatly simplified economy which allows us to easily modify the theoretical model to fit the peculiar conditions obtaining there. Saudi economics is dominated by the

[6] This estimate is based on the assumption that the legal maximum of wives that a Muslim man could have is four.

oil sector, which currently accounts for about a third of its GDP (SAMA 2002). The role of oil in the government revenues is even greater – currently about 80% (SAMA 2002) – and much of the rest of revenue is indirectly tied to oil. As a result, fluctuations in oil prices provide a very reasonable predictor of government revenues (see below). In short, we can assume a single-sector economy without much loss of accuracy. Thus, *R* of the original model, interpreted as the product of commoner labor, becomes the oil-derived state revenues. An important modification of the Al Saud model is to make *R* a variable that fluctuates from year to year in response to changes in oil prices.

Second, in the place of a single class of desert-originating elites we need to put something that is a better approximation of the complex structure of the modern Saudi society. Ideally, we would keep track of the numbers, rates of increase, and consumption levels of at least four different classes:

1. The royal family, consisting of the descendants of the founder of the Saudi dynasty – this is the House of Saud (or Al Saud, hence the name of the model).
2. A small group of commoner businessmen closely associated with the dynasty (example: Osama Bin Laden's father). These individuals have higher incomes and reproductive rates than some of the royal princes.
3. Government employees whose livelihood depends directly on the state budget.
4. The rest of the commoner population, whose salaries derive from other sources than the state budget, but who nevertheless depend on it for subsidized health services, education, and consumption items (such as food and fuel).

Unfortunately, the empirical sources available to me do not allow parameter estimation for all these classes. Accordingly, I compromised by lumping the first two into "elites" and the last two into "commoners" (note that since all four classes have a claim on a share of *R*, they together correspond to the "elites" of the Ibn Khaldun model). Furthermore, since the data about the wealthy associates of Al Saud are even harder to come by than for the royal family (see below) I will further approximate this stratum with just the royal family.

A quick digression on the purposes of modeling

Given this background, we now can write the equations of the model that we will use to predict the future dynamics of the Saudi Arabian polity. Before I do this, however, it would be a good idea to discuss the general logic of the modeling approach I use. The most important thing to keep in mind when constructing a model is that one should not aim to capture the reality in all of its glorious complexity. Experience from many fields of science shows, over and over again, that putting too much complexity in models defeats their purpose and leads to scientific failure of disciplines that insist on doing so. A good model should include only those processes that are critical to making predictions about the output variable (or variables). Of course, when we embark on a modeling exercise, we do not yet know which processes are critical. To find out, we begin by writing the simplest possible model and then sequentially add

various candidate processes to it, at each step testing whether the addition of a process has a substantial effect on the predicted trajectory. Any process that has only a slight effect on model predictions, is ruthlessly expunged from the model, even if we perfectly well know that it operates in the real world. To repeat, the purpose of the predictive model is not a faithful description of the reality, but identification of the key processes one really needs to make accurate predictions about the system trajectory.[7] Therefore, I ask my readers to temporarily suspend their disbelief as they read through the description of the model in the following paragraphs. The equations provide a starting point of the investigation, and the influence of other, non-modeled, processes will be discussed in due time.[8]

In summary, because a good model is a simple model, by necessity it abstracts away from the wealth of specific historical knowledge that we have for the modeled society. The Ibn Khladun model for political cycles in the medieval Maghrib differs from the Al Saud model, because it reflects somewhat different structural assumptions about interrelations between modeled variables. However, the two models are much more similar to each other than the real societies that they describe. Such a similarity is appropriate if the causes of state collapse in the Maghrib are broadly similar to those of the putative collapse of Saudi Arabia. The working hypothesis here is that general theory in historical sociology is possible, and therefore we can abstract away from the wealth of specific historical information when investigating state collapse. The alternative hypothesis, held implicitly by many professional historians, is that each society during each period is unique, and no general theory is possible. Only future can show which alternative is correct.

The equations of the Al Saud model

The "output variable" that we are focusing on is S, the state accumulated surplus (or deficit; in fact, the key question is how the state debt will grow with time). To write the actual equations for S I use a discrete-time formulation because much of the data come as yearly numbers (this approach will also make it easier for others to reproduce my calculations, should they wish to do so; to facilitate such checking I am posting an Excel file with calculations on the Web). The guts of the model are the equation governing the accumulated state surplus (deficit) in year t, S_t:

$$S_{t+1} = S_t + R_t - \mu_c C_t - \mu_e E_t \qquad (1)$$

where S_{t+1} is the next year's value of S (the quantity we are predicting), R_t is the annual state revenue (a function of oil prices), C_t and E_t are the numbers of

[7] This is true in the context of scientific prediction; in other contexts different kinds of models, including purely descriptive, may be appropriate.

[8] Western (2001) provides a very useful perspective on using the Bayesian framework for finding the balance between overly simple and overly complex explanations.

commoners and elites, respectively, and μ_c and μ_e are the annual average income from the state that commoners and elites expect. I will assume that the numbers of commoners and elites grow exponentially:

$$C_{t+1} = r_c C_t$$

where r_c is the per capita growth rate of the commoner population. The equation for the elite numbers is the same, but the growth parameter is r_e.

Parameter estimation

The next step is to obtain estimates of parameters. My main source of quantitative data is the annual reports by the Saudi Arabian Monetary Agency (*e.g.*, SAMA 2002). There are some obvious problems in relying on the official data, but as far as I could determine, the key numbers that I need for parameter estimates check against independent sources (see below for a "quick-and-dirty" test of the theory). The main problem with the official source, as we shall see later, is that it omits some critical information (especially that relating to the finances of the royal family). In Figure 3 I plot some of the critical variables that can be used to estimate model parameters: the Saudi state's revenues and expenditures, population numbers of Saudi Arabia, and the annual fluctuations of oil prices. Saudi finances throughout this article will be given in terms of Saudi Riyals (USD = SR 3.75).

We need to make sense of these raw data. The first observation that we make is that there is a clear connection between the price of oil and total state revenues. The relationship is quite strong, with a linear regression using oil price as the independent variable explaining over 80% of variance in the state revenues (Figure 4a). Note that the dependent variable in this regression is the total annual revenue (derived from both oil and other sources; in fact, "other" revenues also fluctuate in response to oil prices). Thus, we have a simple equation predicting Saudi revenues,

$$R_t = cO_t$$

where O_t is the price of a barrel of oil in dollars, R_t is the Saudi revenue in billions of Riyals, and c is the regression coefficient (the slope of the straight line in Figure 4a). The regression estimate of c = 8.43 SR billion barrel/USD.[9]

State expenditures exhibit a somewhat more complex pattern of fluctuations, because first they are affected by oil prices (via revenues, when the state is flush with revenues the tendency is to spend more, when times are tough, some belt-tightening occurs). But there is also a second important influence that is revealed when we plot *per capita* expenditures (total expenditures divided by population numbers). Per capita expenditures experienced an enormous growth

[9] The weird-looking units of c are a result of the need to balance the units of R_t and O_t.

during the heady days of the 1970s (Figure 4b), when the total revenues of the state skyrocketed and the social contract between the House of Saud and the Saudi population was forged. When the oil prices collapsed in the mid-1980s, the per capita expenditures declined only to a threshold of around SR 10,000. Thereafter, good years (in terms of oil prices) saw upward movement of per capita expenditures, but during the bad years, Saudi rulers ran into difficulties whenever they tried to decrease per capita expenditures below the threshold of about SR 10,000 (more on this below). If this argument is correct, then we have an estimate of the parameter μ_c, the average annual income that commoners have become accustomed to receiving from the state. Thus, $\mu_c \approx$ SR 10,000. (Remember, that this is not a direct handout, but rather a combination of salaries paid to officials and various subsidies that make life easier for everybody.)

The final parameter that the SAMA data yields is the per capita rate of commoner population growth, r_c. Currently it is between 3 and 3.5% per year. Thus, we have reasonably solid estimates of the model parameters relating to the commoner module. What about the elites?

The Saudis are very closemouthed about the internal arrangements within the ruling family. Even the size of the family is a closely kept secret. As a result, I have encountered wildly different estimates in the published literature (mostly news articles). The most reasonable guesstimates appear in a web publication by one of the firms specializing in geopolitical and geoeconomic analysis (STRATFOR 2000).[10] STRATFOR analysts estimate the size of the royal family at between 10,000 and 20,000 members. Reportedly, the minimum allowance, received by the lowest ranked princes is $50,000 per year. The stipends of higher-level princes are in the neighborhood of $1−2 mln, but for those at the top just monthly expenses can run into many millions of dollars. Perhaps the most relevant number is the STRATFOR estimate that about 10% of the Saudi budget goes to the allowances for the ruling family. Another estimate is that the House of Saud's annual budget is around 15% of the national income (Aburish 1995:294). Unfortunately, this expenditure does not appear in the SAMA numbers. According to Saïd Aburish (1995:295), the greater part of the royal budget is taken out of the oil income before it is recorded as national income.

I will assume that there are currently 10,000 princes and that on average they receive $1 mln (SR 3.75 mln) per year. Thus, the total expenditure on the royal family is SR 37.5 bln, which is about 13% of Saudi revenues – right in the middle of the two available estimates.

It is similarly difficult to estimate the rate of population increase characterizing the House of Saud. Some numbers that crop up repeatedly in various publications (which, however, should not add to their credibility – there is a well-known tendency by news reporters to repeat "factoids" over and over again) is that when there were 5,000 princes the family grew at 35−40 princes per

[10] Incidentally, the STRATFOR publication reaches conclusions very similar to those presented here, although their argument is wholly qualitative, not being backed up by an explicit model.

month, implying the annual growth rate of 8−10%. This level seems reasonable in light of the estimate of 8% per year for generalized Islamic elites proposed in the previous section. Thus, let $r_e = 0.08\ \text{yr}^{-1}$.

A "quick-and-dirty" test of the theory

Before we use the model to make projections, we need to run some quick-and-dirty checks on whether Saudi trajectory up to date is consistent with the theoretical predictions (actually, retrodictions). The first variable to check is the state's accumulated surplus, *S*. As we saw in the previous section, the Ibn Khaldun model predicts that *S* should increase during the early phase of a new dynasty, reach a maximum, and then decrease. The Al Saud model predicts a similar qualitative pattern (the quantitative details, such as the timing and the magnitude of the peak in *S*, will depend on how population growth and consumption level parameters change with time). Since we have the time series of annual revenues and expenditures, it is a simple matter to calculate how the state's accumulated surplus/debt evolved with time (this is the variable S_t). As Figure 5a shows, the qualitative shape of the observed trajectory is precisely as predicted by the model. The estimated accumulated surplus reached a peak of SR325 bln in 1982, and declined to negative SR425 bln by the year 2001. Independent information is in general agreement with this estimate. It is reported that during the early 1980s, the Saudi surplus was close to $100 bln (SR 375 bln). The reported public debt in 2002 is SR 650 bln, somewhat greater than the estimated (SR 425 bln). Probably the difference is due to the accumulated interest on the public debt (I could not find any references to interest payments in the SAMA publications; this reticence is probably due to the religious prohibition of usury in Islam).

But could this boom-and-bust pattern be due simply to fluctuating oil prices, rather than effects of population growth? To disentangle the effects of oil prices from that of population growth on *S* we need to run some explicit projections. I employed a simplified version of Equation (1), which omitted the elites term:

$$S_{t+1} = S_t + R_t - \mu_c C_t .$$

Starting the projection in 1970 with $S_{1970} = 0$, I assumed that $R_t = 8.43\ O_t$ (as estimated above, using the historical oil price data for the O_t series). Then, I approximated μ_c = SR 2,500 for the period prior to 1975 and SR 15,000 for the period after 1975. Finally, for C_t I used two scenarios: exponential growth with the historical average of $r_c = 0.04\ \text{yr}^{-1}$ and no growth ($r_c = 0\ \text{yr}^{-1}$). Comparing the two trajectories (Figure 5b) we see that the critical factor is definitely population growth. The projection of the state surplus assuming population growth at the observed rate shows the boom-bust cycle (the quantitative details of the timing and the height of the peak in *S* are not captured accurately, but that is not surprising, since we used a simplified model). By contrast, if there is no popu-

lation growth, then the state surplus continues to rise (oil prices affect the steepness of the rise, but not the qualitative pattern of dynamics).[11]

In other words, the Saudi state trajectory is generally on track postulated by the demographic-structural theory. What other social variables can we check? One of the most important mechanisms leading to the state collapse, as identified by Goldstone, is the rise of aspirant elites and increased intraelite competition. Goldstone proposed that we can measure intraelite competition by the number of individuals seeking higher education. The number of students enrolled in universities and colleges has been growing steadily (Figure 6). Even before the early nineties the rate of growth was quite impressive, but after c.1994 it literally exploded. This "credentialing" revolution (Collins 1979) suggests that recently the competition for higher-level jobs has intensified. Indeed, the major employer of college graduates is the state. Between 1965 and 1985, the number of civil servants increased tenfold (!), which allowed the state to absorb almost all university graduates. After 1985, however, the bureaucratic build-up reached the saturation point, with the result that educated Saudis had to take jobs below their level of competence (Aburish 1995:99). Currently, the unemployment rate among college graduates has been increasing. In general, there is clearly a severe case of "elite overproduction". The new Saudi class of rich merchants, bureaucrats, teachers, doctors, and officers in the armed forces has increased from 2% to 11% of the population by the late eighties (Aburish 1995:100). This numbers, of course, refer to the middle-rank elites; the growth of the high ranks (essentially, the House of Saud) has been commented on earlier.

Other indicators of enhanced sociopolitical stress include the crime statistics: the number of reported crimes increased from 1775 in 1966 to 21,826 in 1985 (Aburish 1995:100). A crime wave, such as that experienced by Saudi Arabia recently, appears to be one of the fairly reliable indicators of the coming demographic-structural crisis in historical data (Fischer 1996).

Projecting model trajectory forward in time

The discrepancy between the calculated and actual debt level in 2002 raises an important point: as the Saudi debt reaches serious proportions, we can no longer neglect the cost of servicing it. Thus, the actual model that I will use in projecting S_t is

$$S_{t+1} = S_t + R_t - \mu_c C_t - \mu_e E_t + gS_t , \qquad (2)$$

where g is the interest rate (the plus sign in front of the gS_t term means that when S_t is negative, the interest is subtracted from it). The mid-1990s data on Saudi debt servicing in Table 5.5 of Wilson and Graham (1994), themselves based on IMF estimates, suggest that $g \approx 7\%$, a reasonable enough rate for a country that can guarantee its debt with oil revenues.

[11] According to the model, if the Saudi population had increased at the rate of 2% per year (instead of 4%), then the government could have kept its budget balanced during the thirty year period.

Using Equation (2) together with equations for the growth of commoner and royal population it is now a simple matter to project S_t forward in time, using the starting 2002 value S_{2002} = SR 650 bln. The Excel file (Al Saud.xls) which accompanies this paper provides a handy tool for accomplishing this projection. Interested readers can also use this spreadsheet to investigate how changing different parameter values (see below) affects the outcome. If we accept parameter values as estimated above (these are our *median* parameter values) and assume, for concreteness sake, the average price of oil equal to $35 per barrel, then we observe that the Saudi debt grows with time at an accelerating rate: the projected debt exceeds SR 1 trillion by 2008, and SR 2 trillions by 2014. Clearly, at some point the state will not be able to secure further financing to cover its mushrooming deficit. Let us say, again for concreteness sake, that the credit dries up when the annual interest payment exceeds the annual state revenue.[12] The projections suggests that bankruptcy, defined in this way, will take place in 2020.

So here we have a concrete number – 2020. Is this the prediction of when Saudi Arabia will experience state collapse? No, because 2020 is just a single number, and meaningless by itself. One of the reasons for exposing the inner workings of the model that lead to this number is to show how tenuous some of the parameter estimates and other assumptions are. Therefore, the next step in constructing a proper scientific prediction is to investigate the effect of various sources of uncertainty on the predicted trajectory. There are three general sources of uncertainty: stochastic exogenous effects, uncertainty associated with parameter estimates, and the effect of structural assumptions of the model. I discuss each of these sources in turn.

Exogenous stochasticity

No model can incorporate all possible factors affecting the real-life processes we study and attempt to predict. The factors left out of the model are called the exogenous effects, and we usually model them as stochastic variables. In our model stochastic variables include fluctuations in population growth rate (*e.g.*, due to an epidemic), interest rates varying with response to global economic conditions, and (most importantly) fluctuating oil prices. In fact, it is so obvious that oil prices will have a dominant effect on the projected trajectory, that I will focus on them exclusively (there is also a possibility of very large-effect – catastrophic – perturbations to the system, but I will deal with them when discussing structural assumptions). In fact, we have already done most of the work, by estimating the relationship between annual oil price and Saudi state revenue. Thus, it becomes a simple matter of investigating various scenarios concerning future oil prices. Here I will simply bracket the estimate by assuming constant low or constant high oil prices. Between 2000 and the Spring of 2005, the price of oil fluctuated roughly between $20 and $50 per barrel. Had

[12] Actually, the financial collapse will probably occur prior to this, but I cannot think of any other simple stopping rule.

the price of oil stayed at $20 from 2002 on, the predicted collapse date would advance to 2011. On the other hand, had it immediately jumped up to $50 and stayed there the day of reckoning would be postponed to 2033. We see now that the point estimate of 2020, based on the intermediate price of $35 per barrel, gave us a quite false feeling of precision. Taking uncertainty in just one factor – oil prices – yields an interval of 22 years; according to the model, state collapse could occur during any year between 2011 and 2033. Actually, this estimate of uncertainty is conservative, because some economists now predict that oil prices could increase to the level of $100 per barrel.

Parameter uncertainty

The next important source of uncertainty is the estimates of parameters. The first thing we should investigate is the effect of the ruling family, because there was so much uncertainty associated with the estimates of the family size and per capita allowances. We can do it in one fell swoop by first, reducing the effect to zero, and second, by doubling it. Surprisingly, the effect is not as strong as might be expected (Table 1). If we completely cut the princes off the feeding trough, we delay the collapse to 2027. Doubling the number of princes (or, alternatively, doubling the estimate of average allowance per prince) advances the collapse date to 2017. There are two important messages here. First, the effect of uncertainty associated with the estimates of princely parameters is substantially less than that associated with future oil prices (10 versus 22 years). Second, and the corollary to the first, although the luxurious life style of many Saudi princes excites much (deserved) opprobium among the commentators, and more importantly the Saudi population, our calculations show that they are only a part of the problem, and not necessarily the main one. As an interesting parallel, Goldstone (1991) showed that before the French revolution of 1789 the court and the aristocracy also were not consuming an especially large part of the revenue.

The next set of parameters to investigate are those for the commoner population: their population growth rate and the average income they get from the state. In principle, both of these rates can decrease with time. Population growth rate in Saudi Arabia was recently close to 4%, and now it has apparently declined below 3.5%. Suppose that it will linearly decline by 1% each decade. Surprisingly, this assumption, or even a more extreme one of 2% decline per decade, shift the collapse date only by one or two years (Table 1). Taking the expectations of government subsidy next, suppose that the government succeeds in persuading the populace to accept a linearly declining μ_c at the rate of SR300 per year (that is, in ten years μ_c will decrease from SR10,000 to 7,000). This would serve to move the collapse date to 2029. By contrast, an increased demand on the state resources of the same magnitude, but opposite direction (resulting, for example, from the necessity to create government jobs to fight unemployment) would shift the date forward to 2017 (Table 1). Finally, the interest rate that the government has to pay to service the debt has a similar – moderate – effect on the trajectory (Table 1).

The effect of structural assumptions: Ibn Khaldun versus IMF

This category of uncertainty in the prediction is the most interesting one from the scientific point of view. In fact, finding out whether structural assumptions are correct is what the empirical test is all about. The issue of structural assumptions can be approached by putting it in the broad context, that is, by considering the theoretical alternatives to the demographic-structural model. We can start delineating alternatives with the New York Times column of Thomas Friedman on February 27, 2002, entitled "One Country, Two Futures". In it, Friedman describes two possible models for Saudi Arabia's future. The first one predicts collapse, using the reasoning broadly consistent with the model developed above. The second model proposes an alternative to collapse by assuming that it is possible to reform the Saudi system both economically and politically. The recipe for modernization is utterly familiar to anybody who follows the news on international political economy. It involves opening up the economy to external competition (which among other things means entering the World Trade Organization), balancing the budget by cutting social spending, and liberalizing the political system with the ultimate goal of rule of law, democracy, and free elections. Since this is the standard package pushed upon the developing world by such organizations as the International Monetary Fund (IMF), let us call it the "IMF alternative".[13]

Both the IMF and the Ibn Khaldun alternatives are based on the logic of *endogenous* development of the Saudi state. Yet Saudi Arabia does not exist in isolation. Its future is affected by the actions of other regional powers, including (in addition to itself) Egypt, Israel, and Iran (Iraq being now out of this equation), superpowers (of which there is currently only one), and non-state networks, such as Al Qaida. There is a possibility that one of these exogenous actors will exert an overwhelming force, which would in a sense "spoil the experiment". One potential scenario, which has already been mooted in the US policy circles, is that the US might decide to intervene militarily in Saudi Arabia by taking over the oil-rich littoral. The rationale of such an intervention might be to overthrow the evil Saudi regime that promotes Islamic terrorism

[13] Here are the actual recommendations made by the IMF's executive board in October 2002, as reported by the Middle East Economic Digest of November 1, 2002: implement a "comprehensive privatization strategy", "use part of the proceeds from privatization to reduce the public debt", "reduce the barriers to inflow of foreign direct investment", approve and implement "the capital market and insurance laws", "balance the budget by 2005", and implement the income tax, with "sales tax as a good interim measure pending the implementation of a fully-fledged value-added tax (VAT)". IMF recommendations are primarily addressing the economic aspects of reforms that Saudi Arabia is urged to pursue. For the political aspect, we can look to an Op-Ed piece in New York Times by Kenneth M. Pollack (October 16, 2003). Pollack is currently director of research at the Saban Center of Middle East Policy at the Brookings Institution and a former director for Persian Gulf affairs at the National Security Council. Commenting on a recent announcement by Saudi Arabia to hold elections for municipal councils with a year, Pollock wrote: "The only way for the Saudis to get at these deep-seated problems is through modernization, and that process has to start with the political system".

world-wide; or, alternatively, to prop up the friendly Saudi regime, our bulwark against the tide of Islamic revolution in the Middle East. The opposite possibility is the American failure in Iraq, leading to the rise of an aggressive Islamist (most likely Shiite) regime there, which would then export Islamic revolution to the Shiite areas of Saudi Arabia (who predominate in, again, the oil-rich littoral). One can multiply the scenarios, but these two or three should suffice. I do not know how probable any of them are, but the important point is that we do not need to have this information. This is because we are concerned here not with a forecast, but with setting up a scientific prediction. Any of the scenarios mentioned above, let us call them "the exogenous intervention" alternative, would result in "spoiling the experiment", which concerns the prediction of how endogenous dynamics of Saudi Arabia will develop. Thus, what we have to do is to predicate the empirical test on the exogenous intervention *not happening*. If the international environment allows Saudi Arabia to develop endogenously, then we have our test, if not, we are out of luck – we will not know who is right in this particular case, Ibn Khaldun or IMF.

Returning to the two endogenous alternatives, we can use them to structure the discussion of structural assumptions of the Al Saud model.

Delivering significant economic growth. The most important assumption of the IMF scenario is that it is possible to stimulate substantial economic growth in Saudi Arabia. Since the population is growing very rapidly (at more than 3% per year), in order for per capita incomes to increase in a noticeable manner, the GNP needs to grow even faster. Furthermore, as a result of age structure dominated by youthful cohorts, the Saudi labor force is currently growing at 4.5% per year (Hatrash and Fareed 2002). In order for the country to go beyond the mere absorption of new workers, the long-term growth rate in GDP must be no less than 6% (Hatrash and Fareed 2002). The Ibn Khaldun alternative, at least as formalized in model (2), explicitly assumes 0% GNP growth in the non-oil sector, and no growth of oil-related GNP except that entirely driven by oil prices. In other words, the Saudi state will continue to rely exclusively on oil revenues. The truth is likely to be somewhere in between, and the empirical issue is whether substantial economic growth can be delivered, or whether it will be too slow for per capita incomes to rise appreciably (if not decline). The past record of IMF and the World Bank in delivering economic growth is not good (Naiman and Watkins 1999, Easterly 2001).

Cutting budget deficit. In the short run (as opposed to the possibility of long-term economic growth), this will have to be done by reducing government expenses and/or raising taxes. Since the bulk of expenditures goes to the salaries for government employees (60%) and social programs, any expenditure-reducing measures will immediately affect the quality of life for the Saudi population. It is doubtful that this can be done. The Saudi population has become accustomed to the state subsidies during the 1970s, when state revenues expanded as a result of upsurge in the oil prices (Figures 3 and 4b). When oil price collapsed in the early 1980s, the Saudi economy went into recession, and the state started running huge budget deficits. This forced the government to re-

assess the Kingdom's generous welfare program with its costly reliance on subsidies (Wilson and Graham 1994:185). The Saudi government was able to erase some subsidies on agricultural products. The government was lucky in that this action coincided with falling agricultural commodity prices (previous attempts to cut agricultural subsidies had run into stiff opposition). Other attempts at erasing subsidies (on gasoline, water, and electricity), however, were unsuccessful in the face of immediate protests. Plans to increase the price of gasoline and electricity, announced in 1984, were rescinded the next year. These setbacks forced the government to shift its track in 1987−8 and try to increase revenues. The revenue-increasing measures included new user fees (*e.g.*, an airport departure tax) and imposing an income tax on repatriates. "Four days after it has been published, the expatriate tax was withdrawn. Two weeks later, most of the … user fees were scrapped in the face of mounting domestic pressure" (Wilson and Graham 1994:186-9). Another unsuccessful attempt to reduce subsidies occurred in 1992. Again, the resulting outcry forced King Fahd to rescind his decision before it was applied and instead he had to increase some subsidies to placate the people (Aburish 1995:306). As of the time that this paper was written, despite the IMF calls for implementing the income tax, the Saudi government has repeatedly stated that it has no plans to do so (except on the expatriates, but so far it has not taken any concrete steps to do it). Thus, it is an empirical observation that the Saudi government has been unable to reduce the budget deficit, by any means, whenever oil prices collapsed. Each time these measures provoked significant public resistance and unrest, and had to be rescinded. Furthermore, it can be argued that the very foundation of the social contract on which the Saudi regime is based is the commitment to spread the oil wealth around. Any movement away from continued social spending immediately undermines the legitimacy of the regime.

The effect of a sharp and substantial rise in oil revenues. After the first version of this paper was written (in December 2003), world oil prices soared, doubling and even tripling oil revenues of the Saudi state. This event provides a graphic illustration of the point already made in the first version, that an accurate forecast of the Saudi trajectory is impossible. How does it affect the predictions of the Al Saud model? If the price of oil increases beyond the level of $50-60 per barrel and stays there indefinitely, and if all other parameters of the model are fixed at their median values, then the year of predicted collapse is postponed so far in the future that the prediction of collapse loses any meaning. Or, to put it another way, the prediction of the model becomes that for the foreseeable future (say, the next three decades), the Saudi state is *not* going to collapse. However, at least two factors should work to prevent an indefinite postponement of collapse. First, oil is not a renewable resource. Even if oil prices stay high, revenues will collapse once the Saudi oil reserves are exhausted. Second, the budgetary surplus resulting from the growth in state revenues will put the pressure on the state to spend more on the social programs and to increase personal allowances to the princes. Increased expenditures will quickly "eat up" the surplus. After this point, population growth, possibly combined

with declining oil revenues (which could be due to either lower oil prices, or decreasing production) will result in growing budget deficit. This is what happened after the boom decade of the 1970s, and it is possible that the history will repeat itself.

Reducing population growth. The present regime, given its dependence on conservative Muslim (Wahhabite) clerics, cannot propose any population-control measures. On the other hand, it is possible that population growth rates will decline on their own, as a result of deep social forces acting on individuals. It is a fallacy to assume that Muslim populations are incapable of collectively reducing their fertility rate – the best counterexample is the recent fertility collapse to the replacement level in Iran (and under a theocratic regime, to boot). On the other hand, the Iranian fertility decline occurred after more than a generation of heightened sociopolitical instability. It takes time for social mores to change. Furthermore, even if the Saudi fertility were to be reduced to the replacement level tomorrow, it would still take multiple years before the actual population growth would cease. This is known as the demographic inertia effect, and again it takes about a generation for things to equilibrate. What all this means is that there is a substantial lag time (a generation or more) before any social changes will percolate to a reduced rate of population growth. According to the model calculations, Saudi Arabia does not have this time.

Liberalizing the political system. The Ibn Khaldun scenario assumes that the Saudi elites will continue to cling to power to the bitter end, and go down with the state, when everything collapses. This is of course what invariably happened in pre-modern times. The modern era, by contrast, knows a number of examples of peaceful power transition from autocratic to democratic regimes. The IMF scenario assumes that this is a realistic option for Saudi Arabia. Some kind of opening of the political system may in fact be necessary in order to push through unpopular, but needed reforms, the argument goes.

Actually, I would argue that the logic is inverse: autocratic (but perceived as legitimate) regimes seem to have a better track record in pushing through unpopular reforms (I admit, though, that I am not familiar with any quantitative studies on this subject). In any case, it is not clear at all that the Saudi elites would be willing to allow any liberalization. After all, reforming the system is an extremely risky business for the elites involved, as the Shah of Iran and Mikhail Gorbachev found for themselves. The Saudi ruling class is quite aware of this danger.[14]

Furthermore, by implementing any changes in the political system, the Saudi elites will be cutting themselves off from power and wealth. This does not seem like a very rational strategy. A clear-headed Saudi prince might be com-

[14] As reported by Elaine Sciolino in the New York Times of November 4, 2001. Prince Bandar bin Sultan, the Saudi ambassador in Washington told her about a letter exchange in the late 1960s between the Shah of Iran and King Faisal. The shah advised the king to modernize his country, because otherwise he could not guarantee that Faisal would stay on his throne. Faisal wrote back, thanking the shah for the advice, but refused to follow it. "History proved our point", concluded Prince Bandar.

pletely aware of the collapse to come, in which case the most rational strategy is to continue milking the Saudi oil revenues for as long as possible, salt away most of the wealth abroad, and when the system collapse leave the country to live off the accumulated wealth. Any rocking of the boat may only hasten the inevitable end.

Buying time by selling assets. Opening up economy and privatizing government property, as some liberal economists urge, may result in one positive side-effect: using the proceeds from privatization to finance the deficit. Such a strategy could, in principle, stave off the collapse by some years. In fact, we can even obtain some quantitative estimates. The state controls one-third of shares on the Saudi stock exchange, whose total capitalization is $80 bln. Thus, the state share is SR 100 bln, or less than one-sixth of the 2002 deficit. In other words, selling the state controlled shares will only stave off the collapse by 2 months.

What about selling ARAMCO, the state-owned oil company? This is after all the main asset of the House of Saud. It is highly dubious that this is politically possible, but let us estimate (to the order of magnitude) how much money could be raised in this way. Saudi Arabia can produce over 11 mln barrels of oil per day. At $35 per barrel this is equivalent to $140 bln. Thus, ARAMCO is worth anywhere between $1.4 trillion (assuming a 10% return rate on investment) and $2.8 trillion (assuming 5% return). This is a major amount of money, and if such a sale could be done, it would postpone the collapse by decades. Nevertheless, my guess is that selling off ARAMCO, whether wholesale or piecemeal, is a course of action that is politically unacceptable.

What are the consequences of fiscal collapse? One important assumption of the "Ibn Khaldun scenario" is that financial collapse of the Saudi government inevitably leads to the state collapse, followed by a combination of intraelite conflict and elite-mobilized and popular uprisings; in short, a protracted period of civil war. This is the typical trajectory in historical case-studies examined by Jack Goldstone (1991), but it would be foolish to claim that precisely the same is going to happen in today's world. After all, some modern democratic societies have experienced bankruptcy (the most recent example being Argentina), which resulted in the fall of the government but hardly civil war. However, there are reasons to doubt that the fall of the Saudi regime will lead to a peaceful and rapid transition to some other regime. In my opinion, just about the only remotely possible manner in which bloodshed could be avoided is a rapid takeover of the state by Bin Laden types. This is obviously a highly unpalatable outcome from the point of view of the Western world, and it is precisely this course of events that might trigger the intervention by the US. But this is just a guess, the main point I want to emphasize here is that the formal prediction of the Saudi trajectory stops at the point of fiscal meltdown. What happens after that point is beyond the scope of the exercise. Incidentally, this point of high trajectory indeterminacy following state collapse is discussed by Goldstone (1991).

Structural assumptions: a summary. One useful end result of considering the structural assumptions above is that we can see that the Ibn Khaldun and the IMF alternatives constitute the ends of a continuous spectrum. Thus, (and assuming that the exogenous intervention does not occur), it is conceivable that some sort of mixed scenario is what will actually happen. For example, there could be some moderate economic growth, Crown Prince Abdullah might succeed in reforming the system, the public may agree to some decrease in the state subsidies, etc. Will that be enough to prevent the fiscal followed by political collapse? The advantage of proposing an explicit model, as I did in this paper, is that all these questions are answerable. In fact, I have already investigated such effects as declining population growth or willingness to accept lower state expenditures on the part of population. Adding some terms to the model representing the effects of growing GNP is quite straightforward.

DISCUSSION

My main goal in this paper was to discuss the role that scientific prediction (which I distinguish from a mere forecast) can play in advancing the state of art in macrosociology. The bulk of the paper was devoted to constructing a case study in prediction, focusing on the possibility of state collapse in Saudi Arabia during the next three decades. I think most social scientists will agree that predicting a revolution is not a trivial task, in fact some feel it is outright impossible (Kuran 1995). Indeed, a credible *forecast* of Saudi Arabia's future is impossible, given the current state of social science (if at all – see the discussion above about the impossibility of long-term forecasts in chaotic dynamical systems). On the other hand, I argue that we can set up an empirical test that will allow us to distinguish between predictions of two rival theories (the comparison that I termed "Ibn Khladun versus IMF"). The strength of this approach, which I term scientific prediction, is that no matter what happens − the actual trajectory matching more closely the Ibn Khaldun or the IMF, or even some other unanticipated scenario −, we will learn something useful (with the proviso that Saudi dynamics are allowed by external forces to develop largely endogenously).[15]

One of the key elements in making a scientific prediction is to publish the explicit algorithm on which it is based, so that others can use it to check on the internal logic and the empirical basis (*e.g.*, parameter estimates) of the mechanism for generating predictions. Having an explicit parameterized model will be particularly important during the *post-mortem* stage of the analysis (once Saudi Arabia went into collapse, or alternatively after three decades have passed without it going into collapse). We can take it for granted that the future will bring some surprises and therefore the actual trajectory will be different from the predicted one. The job of the post-mortem analysis is to determine the

[15] Personally, in fact, I hope that the Ibn Khaldun prediction fails, since I wish nothing but good to the people of Saudi Arabia, and hope that they will be able somehow to avoid the misery and suffering of civil war.

source of deviations between the predictions and the reality. Some deviations do not challenge the theory. For example, it is impossible to predict how oil prices will behave – if I could do that, I would not be teaching undergraduates for living. During the post-mortem stage, however, we can simply substitute the observed time series of oil prices. Same with parameter uncertainty – many things (*e.g.*, the number of royal princes) will probably come to light at some time in future, and better parameters can be substituted in the model in place of the preliminary estimates. But the real challenge (and the real test) is whether the model has correctly identified the main structural variables underlying the Saudi sociopolitical dynamics, and made the correct structural assumptions about how these variables affect each other. The main goal of the post-mortem analysis is to identify which of the structural assumptions held and which did not.

It is clear from the preceding paragraph that I consider the post-mortem analysis a key part of the whole exercise. Lack of a *quantitative* post-mortem analysis is perhaps my main critique of one of the most successful cases of prediction in historical sociology, Randall Collins' prediction of the Soviet collapse. The geopolitical model of Collins is eminently quantifiable (see, for example the explicit models by Hanneman *et al.* 1995, Turchin 2003). It would be a laborious, but doable exercise to estimate the geopolitical burden carried by the Soviet Union, and the additional strain of the Afghan war, which is when the tipping point was reached in the Collins scenario (Collins 1995:1568). And, incidentally, it would be interesting to see whether the US is in a similar position, given its current involvement in Afghanistan, and most importantly Iraq. Does the geopolitical theory predict the US decline? The data needed to answer this question are widely available.

The point of my criticism is not to belittle the achievement by Randall Collins; in fact, his prediction of the Soviet collapse stands out as the best example to date. The alternative theories, such as that of an impervious totalitarian colossus, have been decisively put out of the picture. But in order to have further progress, we need to shift from qualitative theories to ones that can be translated into explicit quantitative models. For example, I am not convinced yet that the geopolitical angle is the whole, or even the most important part of the story of the Soviet collapse.[16] We need to test it against the, for example, demographic-structural alternative (and others; now that the Soviet Union has collapsed, the number of explanations for this event are proliferating). It is imperative to expand the number of worked-out case studies, because a mature theory cannot stand on a single empirical case, no matter how wonderful. The number of case studies need not be huge – perhaps half-a-dozen or ten would do: Iran to supplement Saudi Arabia, Yugoslavia to supplement the Soviet Union, one-two from Latin America, Southern Europe, and Africa. I believe that once we have

[16] Note, also, that I did not use the geopolitical theory of Collins as an alternative in the Al Saud case study, because doing so would be creating a patent "strawman". There are no indications, as far as I know, that present-day Saudi Arabia suffers from an imperial overstretch in any form.

such a sample, general insights would emerge almost inevitably, and we will have a mature sociological theory of state collapse.

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Table 1. The effect of various assumptions in the prediction when Saudi Arabia goes bankrupt. (Median prediction = 2020)

Parameter	Early	Late
Oil price per barrel (median $35): early = $20, late = $50	2011	2033
The drain of prince allowances on the budget: late = 0, early = double the median	2017	2027
Population growth rate of commoners: early = declines by 1% per decade, late = by 2% per decade (median = no change)	2021	2022
Change in μ_c: early = increase of SR 300 per year, late = decrease of SR 300 per year (median = no change)	2017	2029
Interest rate: early = 10%, late = 5% (median = 7%)	2016	2025

NOTE. "Early" refers to the value of parameter that advances the date of collapse; "late" refers to the opposite value that delays collapse.

Figure 1. A test of out-of-sample prediction of the proportion of Christians in the Roman Empire

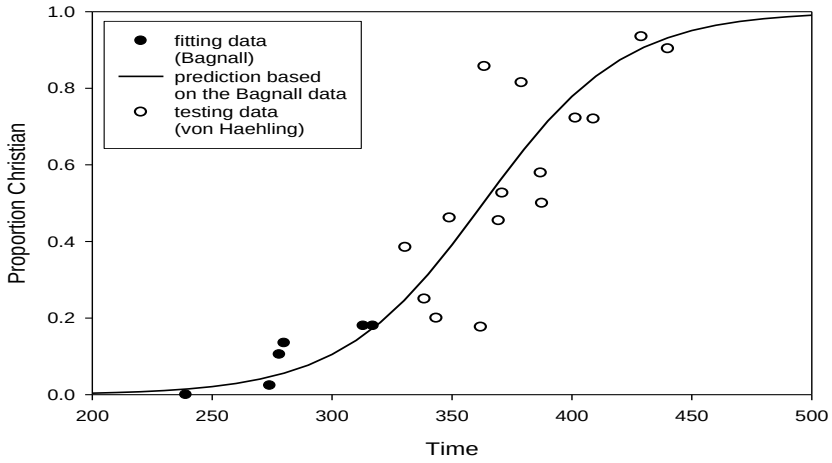

fitting data
(Bagnall)
prediction based
on the Bagnall data
testing data
(von Haehling)
Proportion Christian
Time
1.0
0.8
0.6
0.4
0.2
0.0
200
250
300
350
400
450
500

Figure 2.

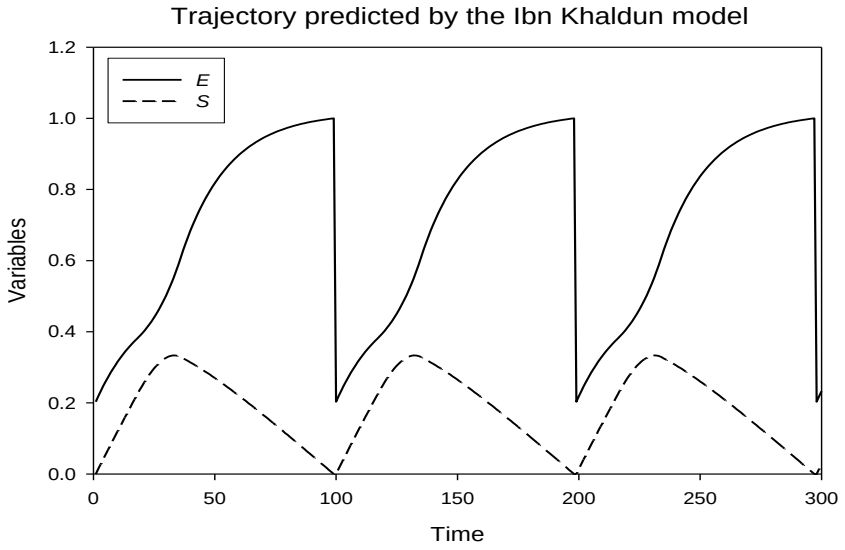


Figure 3. Financial and population data from the Saudi Arabian Monetary Authority (SAMA).

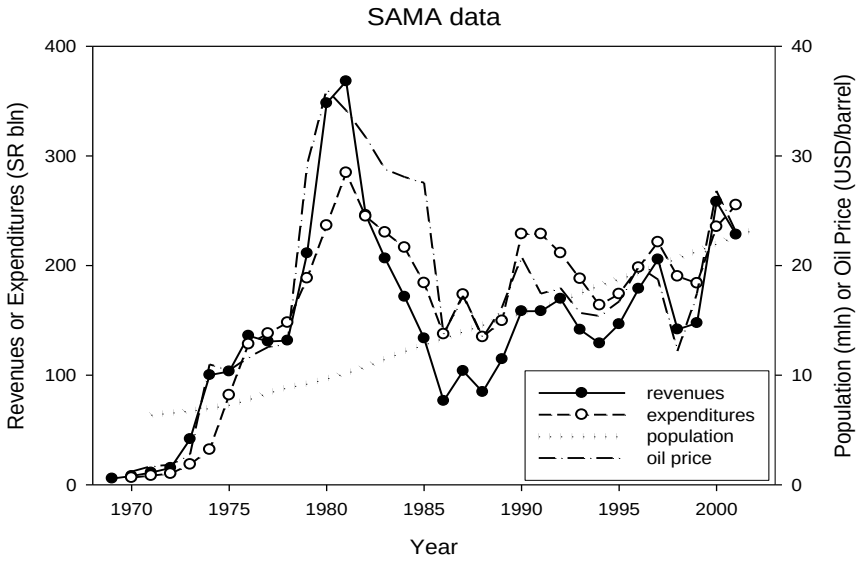


Figure 4. Analysis of the SAMA data

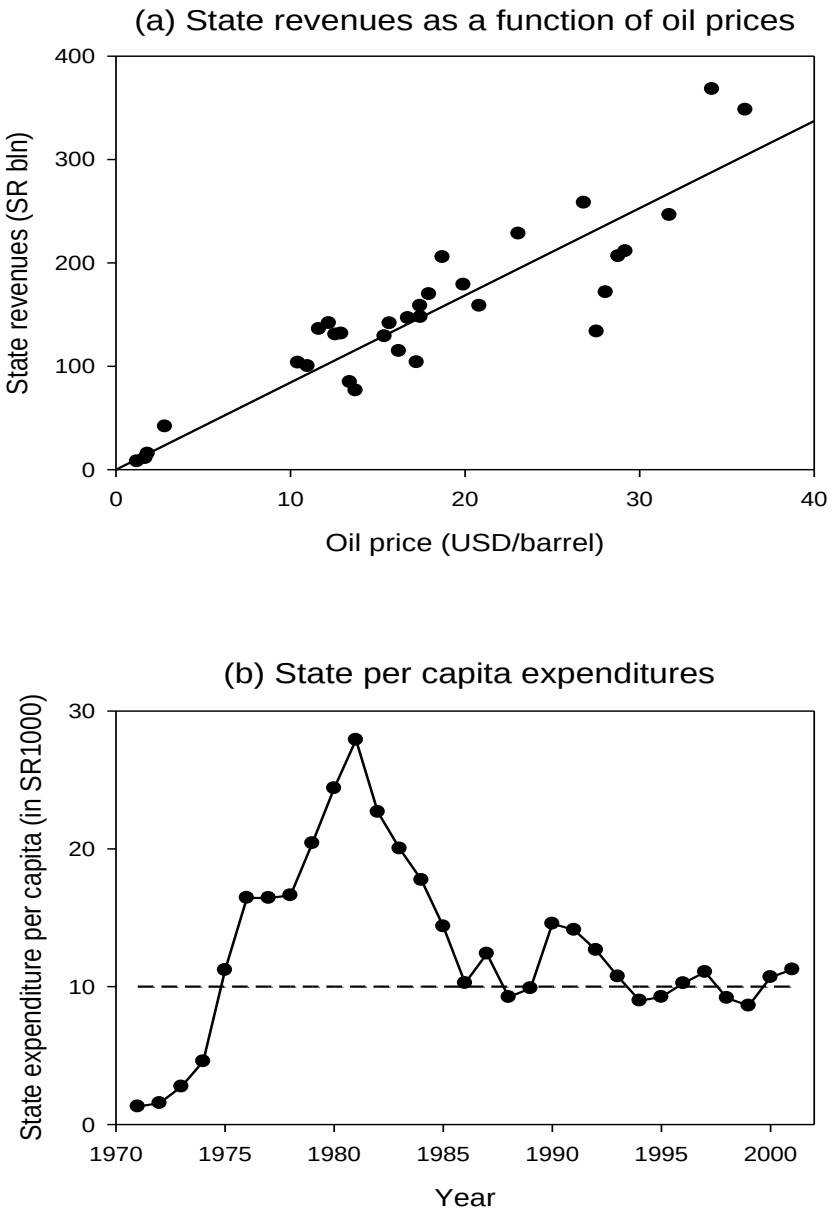


Figure 5. Financial and social indicators in Saudi Arabia.
(a) Estimated surplus/debt.
(b) Two projections of the state surplus/debt:
with population growth (r_c = 0.04) and without

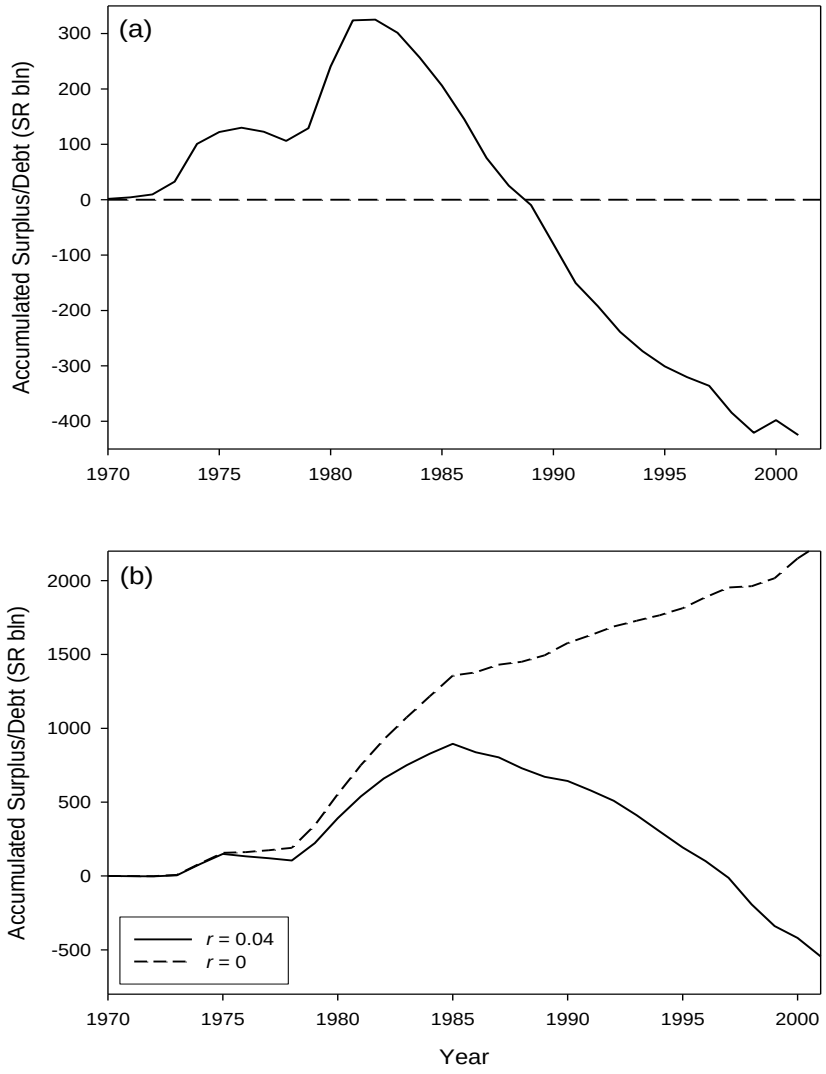
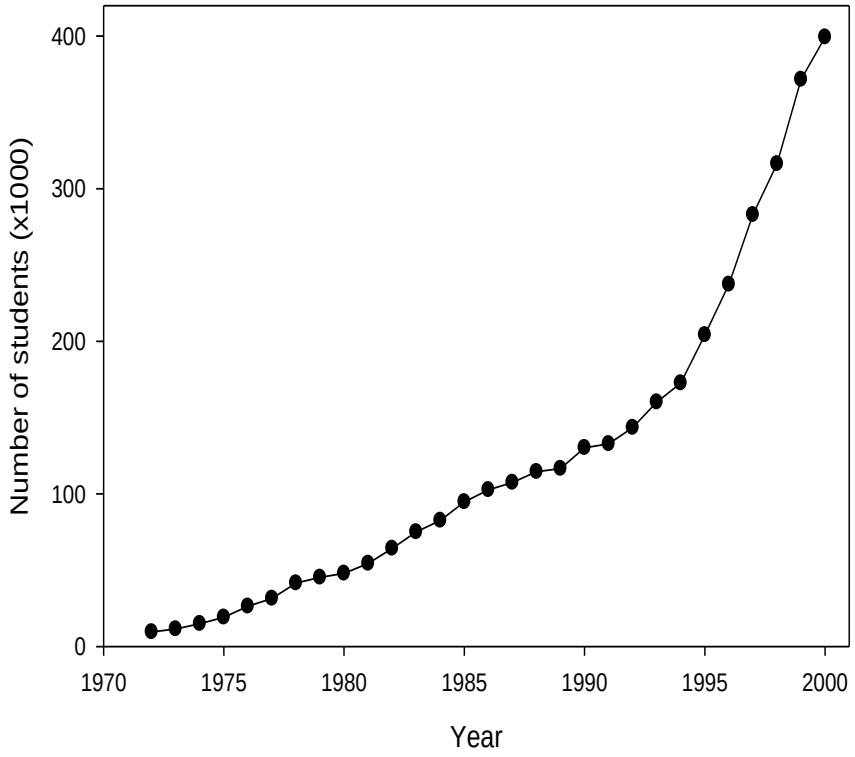


Figure 6. Financial and social indicators in Saudi Arabia, continued: the number of students in the institutions of higher education.



Logical and Explanative Characteristics of Evolutionary Theories

Jürgen Klüver

In a general sense human history is nothing else than a special kind of evolutionary processes, although an extremely complex one. Therefore, the logic of theories that intend to explain general features of historical processes should be of the same kind of evolutionary theories in general. In particular, if such historical theories shall have some explanative power the approach of time series analysis is not sufficient because such an approach remains by necessity on a phenomenological level. Hence, the task of constructing explanative theories of historical processes is twofold: On the one hand one has to look for the level on which causes for historical phenomena may be found and on the other hand one has to decide by which logical and/or mathematical structure such theories must be characterized. I shall first deal with the second question and then with the first one. Subsequently I sketch an according theory, based on a specific mathematical model, named the "Socio-Cultural Algorithm" (SCA).

The physicist John Barrow (1991) once asked if "the Universe is a structure or a program?" As was to be expected, his answer is "both": "Structure" refers to universal and time independent characteristics of the universe, usually represented by general equations. "Program" refers to the evolutionary aspect of the universe, *i.e.* the question not only of its origins but also of the driving forces of the evolutionary development. As "program" in a mathematical sense means "algorithm" Barrow's question is if mathematical theories of the universe should be represented as general systems of equations or by equally general algorithms. Obviously this depends on the particular *Erkenntnisinteresse* (Habermas), *i.e.* the specific questions one wants to answer by a mathematical theory.

Evolutionary theories, therefore, can be best mathematically formulated by the characterization of the specific algorithms that represent the driving forces of the developmental processes. The most famous example for such evolutionary algorithms is the modern synthesis of biological evolution with its "genetic algorithm" of variation and selection (cf. Dennett 1996). Other prominent examples are Marx' theory of Historical Materialism, *i.e.* the driving force of the development of the forces of production (*Produktivkräfte),* and the developmental theory of Piaget, *i.e.*, the mechanisms of assimilation and accommodation (cf. Klüver 2003). A mathematical theory of human history, which means a theory of sociocultural evolution, should contain as its core an according algorithm.

It is a truism that history is produced by human beings. Yet they do so not as specific individuals but as *social beings, i.e.* as social actors who occupy a certain social role. In this fundamental sense the level on which causes for social processes must be looked for is the level of social actors and their actions according to their specific social roles. A social role can be understood as a pair (*r, k*) if r means the social rules by which the role is characterized and k means the role specific knowledge. A medical doctor for example must obey specific social rules, defined in the famous oath of Hippocrates, and has at his disposal the medical knowledge concerning certain diseases and the according therapies. Thus we obtain an explanatory definition of sociocultural evolution: It is the changing and creation of social rules by means of changing and enlarging the role specific knowledge and the according sets of social rules (cf. Klüver 2002). The driving force of sociocultural evolution, therefore, is the enlargement of knowledge and the according variation of social structure, *i.e.*, social rules by the creative thinking and actions of social actors. The fundamental assumption behind these definitions is the fact that the emergence of social roles increases the efficiency of a society via the specialization on certain tasks. In the words of Habermas (1981) social roles increase the steering capacity of a social system.

By defining "social role" as the conceptual unit of theories of sociocultural evolution one has to take into account an important distinction: On the one hand there are "creative" or "technical" roles respectively whose occupants are responsible for the cultural development. Such roles are, e.g., those of technicians, artisans, artists and scientists. On the other hand there are "cultural" roles like those of priests and politicians. These role occupants are responsible for the maintenance of culture, to remind of Parsons, and operate in a more conservative way. It seems rather obvious that the developmental chance of a society depends on the sociocultural relations between those two kinds of roles. If for example the cultural roles inhibit the occupants of creative roles in a strict fashion no sociocultural evolution is possible. If on the other hand the occupants of creative roles are rather autonomous with respect to the cultural roles cultural development is possible. The first case is characteristic, e.g. for the society of feudal China or the Islamic societies during the Middle Ages; the second is the main feature of Europe after Reformation and Enlightenment.

On the basis of the mentioned considerations we (Jörn Schmidt and I) constructed an according program, named the sociocultural algorithm (SCA). The occupants of certain roles are represented by cells on a grid. The artificial actors can learn from one another and can also generate new ideas. Occupants of cultural roles inhibit the production new ideas in certain strength. Therefore, the decisive evolutionary factor in our model is the so-called EP-value: EP means the evolutionary parameter that is computed by the relation between cultural and creative roles. If EP is small, the occupants of creative roles are free to produce new ideas and vice versa. Details concerning this model can be looked up in *An Essay Concerning Sociocultural Evolution* (Klüver 2002).

An historical comparison between, for example, feudal China and the Islamic societies at the Middle Ages on the one hand and medieval Europe on the other hand confirms that assumption: Both China and the Islamic societies were much more developed than medieval Europe. Yet both cultures stagnated, *i.e.* got caught in a "cultural attractor", whereas Europe in the process of Reformation and Enlightenment unfolded an evolutionary force. The explanation is that in China the ruling Mandarins (cultural role) successfully hindered the occupants of creative roles to unfold their capabilities (cf. Needham 1970); in a similar sense the homogeneity of Islamic culture stopped cultural development by the dominant role of the religion (Klüver 2002). In contrast to that even medieval Europe was characterized by a rather high degree of role autonomy of the creative roles, which was politically established by the relative freedom of the large trading towns, organized, e.g. in the Northern *Hanse* or the league of the Flemish cities.

The evolutionary parameter EP has another important characteristic. Even in medieval Europe the degree of role autonomy, measured by the according EP-value, was initially not small enough to generate the sociocultural evolution like that of European modernity. The European development can only be explained by assuming that initial favorable EP-values start an evolutionary process that causes a variation of the initial EP-values themselves. In other words, initial favorable EP-values generate a process by which the EP-values decrease. This logic of evolutionary processes may be called "the evolution of evolution".

We were able to confirm these theoretical hypotheses concerning the relation between different kinds of roles by demonstrating that in most cases of simulation runs the evolutionary process stagnated because of unfavorable EP-values. That is indeed the case in human history, as in particular the great British historian Toynbee noted in his monumental work (1934–1961). Only in the few cases with favorable EP-values the process of cultural development went on. Figure 1 shows a typical "Toynbee development" and Figure 2 demonstrates a development, which is characteristic of the evolution of modern Western culture.

To be sure, simulations *per se* are not sufficient to prove the final truth of a theory on sociocultural evolution. Yet our sociocultural algorithm demonstrates not only the satisfactory possibility of applying mathematical tools to historical processes but also the soundness of the mentioned theoretical and meta theoretical considerations. It is possible too to apply the SCA on the task of the prediction of certain societies. Yet this is another story.

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Figure 1. A Toynbee Development

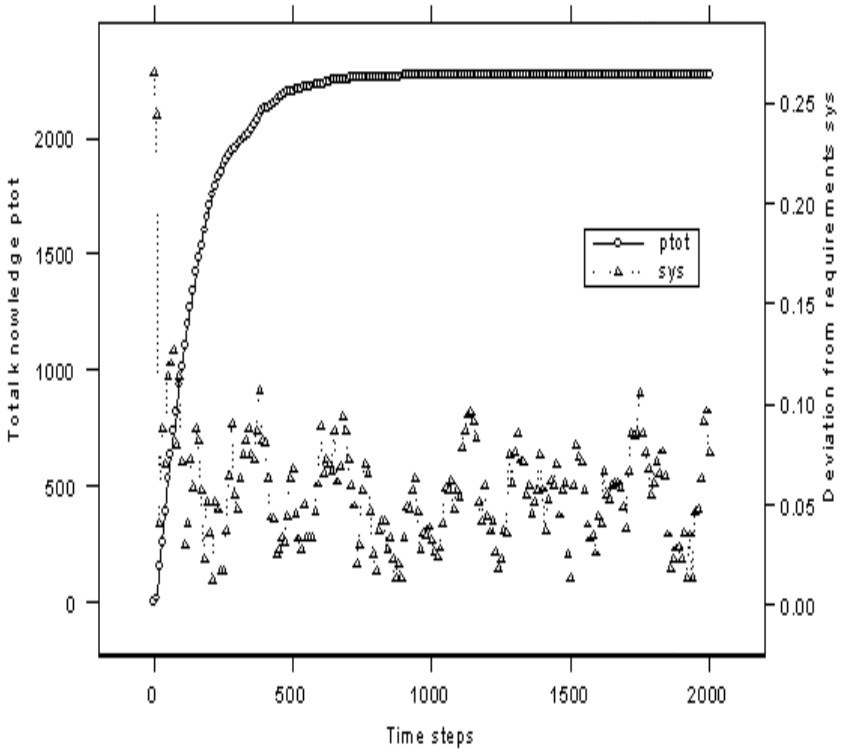
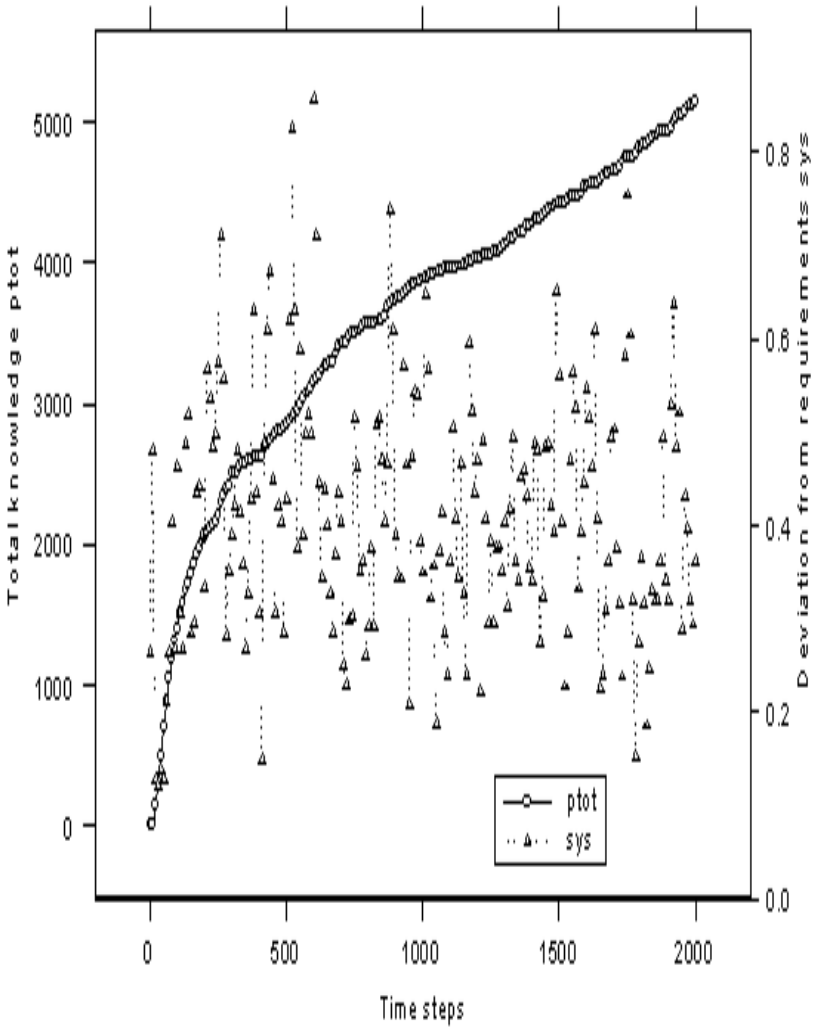


Figure 2. Development Characteristic for the European Modernity



The World System Urbanization Dynamics: A quantitative analysis[1]

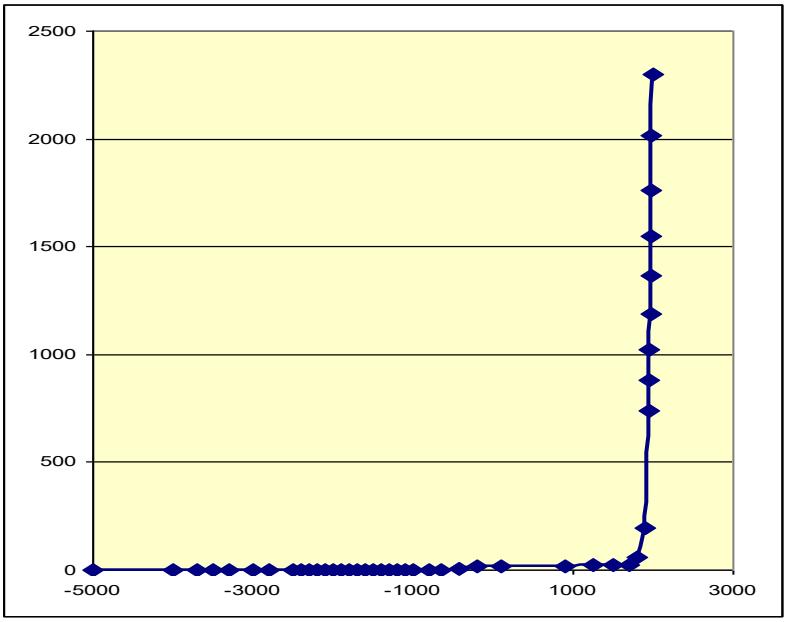
Andrey Korotayev

The available estimates of the World System[2] urban population up to 1990 may be plotted graphically in the following way (see Diagram 1):

[1] This research has been supported by the Russian Foundation for Basic Research (Project # 06–06–80459a) and the Russian Science Support Foundation.

[2] We are speaking here about the system that originated in the early Holocene in the Middle East in direct connection with the start of the Agrarian ("Neolithic") revolution, and that eventually encompassed the whole world. With Andre Gunder Frank (1990, 1993) we denote this system as "the World System". As we have shown (Korotayev, Malkov, and Khaltourina 2006a, 2006b), this was the World System development that produced the hyperbolic trend of the world's population growth. The presence of a hyperbolic trend itself indicates that the major part of the respective entity (that is, the world population in our case) had a systemic unity; and we believe that the evidence for this unity is readily available. Indeed, we have evidence for the systematic spread of major innovations (domesticated cereals, cattle, sheep, goats, horses, plow, wheel, copper, bronze, and later iron technology, and so on) throughout the whole North African – Eurasian Oikumene for a few millennia BCE (see, *e.g.*, Чубаров 1991, or Diamond 1999 for a synthesis of such evidence). As a result, the evolution of societies in this part of the world, already at this time, cannot be regarded as truly independent. Note, of course, that there would be no grounds for speaking about a World System stretching from the Atlantic to the Pacific, even at the beginning of the 1st millennium CE, if we applied the "bulk-good" criterion suggested by Wallerstein (1974, 1987, 2004), as there was no movement of bulk goods at all between, say, China and Europe at this time (as we have no reason to disagree with Wallerstein in his classification of the 1st century Chinese silk reaching Europe as a luxury rather than a bulk good). However, the 1st century CE (and even the 1st millennium BCE) World System definitely qualifies as such if we apply the "softer" information-network criterion suggested by Chase-Dunn and Hall (1997). Note that at our level of analysis the presence of an information network covering the whole World System is a perfectly sufficient condition, which makes it possible to consider this system as a single evolving entity. Yes, in the 1st millennium BCE any bulk goods could hardly penetrate from the Pacific coast of Eurasia to its Atlantic coast. However, the World System had reached by that time such a level of integration that iron metallurgy could spread through the whole of the World System within a few centuries. Another important point appears to be that even by the 1st century CE the World System had encompassed appreciably less than 90 per cent of all the inhabitable landmass. However, it appears much more important that already by the 1st century CE more than 90% of the world population lived precisely in those parts of the world that were integral parts of the World System (the Mediterrannean region, the Middle East, as well as South, Central, and East Asia) (see, *e.g.*, Durand 1977: 256), whereas almost all the urban population of the world was concentrated just within the World System. A few millennia before, we would find another belt of societies strikingly similar in level and character of cultural complexity, stretching from the Balkans up to the Indus Valley outskirts, that also encompassed most of the world population of that time (Peregrine and Ember 2001: vols. 4 and 8; Peregrine 2003). Thus, already for many millennia the dynamics of the world population, the world urbanization, the world political centralization and so on reflect first of all the dynamics of population, urbanization, political centralization, *etc.*, of the World System that makes it possible to describe them with mathematical macromodels.

Diagram 1. Dynamics of the World Urban Population (millions), for cities with > 10000 inhabitants (5000 BCE – 1990 CE)



NOTES. Data sources: Modelski 2003; Gruebler 2006; UN Population Division 2006. Modelski provides his estimates of the world urban population (for cities with >10000 inhabitants) for the period till 1000 BCE, Gruebler's estimates cover the period between 900 and 1950 CE, whereas the UN's estimates cover the period after 1950. The estimates of the world urban population for the period between 1000 BCE and 900 CE were produced on the basis of Chandler's (1987) data on the world urban population living in large cities (with >40000 inhabitants).

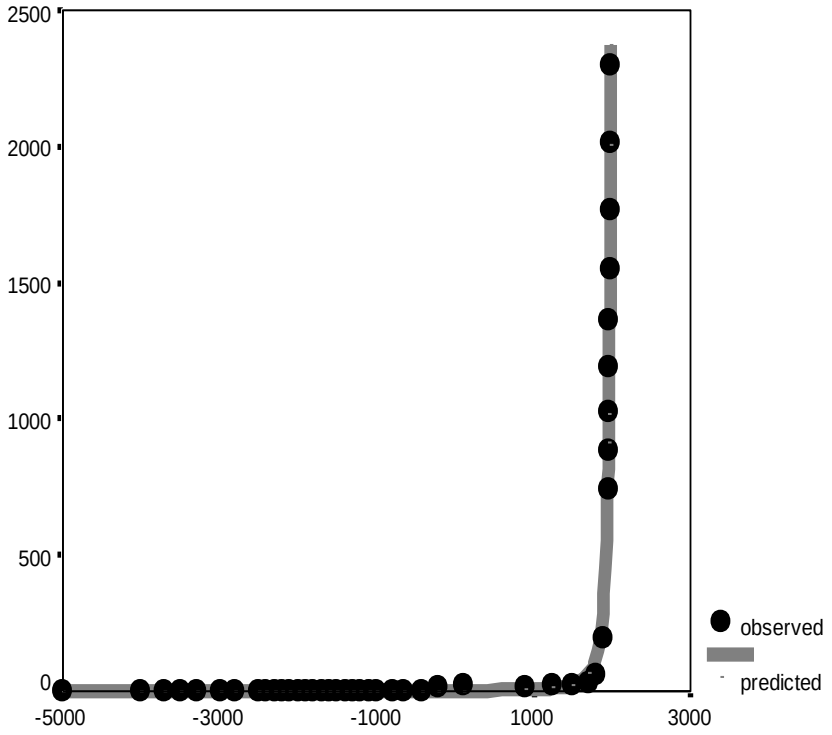
As has been shown by us earlier (see, *e.g.*, Коротаев 2006; Коротаев, Малков, Халтурина 2006; Korotayev, Malkov, and Khaltourina 2006b), the overall dynamics of the world urban population up to the 1990s are described mathematically in a rather accurate way by the following quadratic-hyperbolic equation:

$$U_t = \frac{C}{(t_0 - t)^2}, \qquad (1)$$

where U_t is the world urban population in the moment t, whereas C and t_0 are constants, with t_0 corresponding to an absolute limit ("singularity" point) at which U would become infinite if the world urban population growth trend observed by the 1990s continued further.

Thus, for the period between 5000 BCE and 1990 CE the correlation between the dynamics generated by equation (1) and empirical estimates looks as follows (see Diagram 2):

Diagram 2. World Urban Population Dynamics (in millions), for cities with > 10000 inhabitants (5000 BCE – 1990 CE): correlation between the dynamics generated by the quadratic-hyperbolic model and empirical estimates



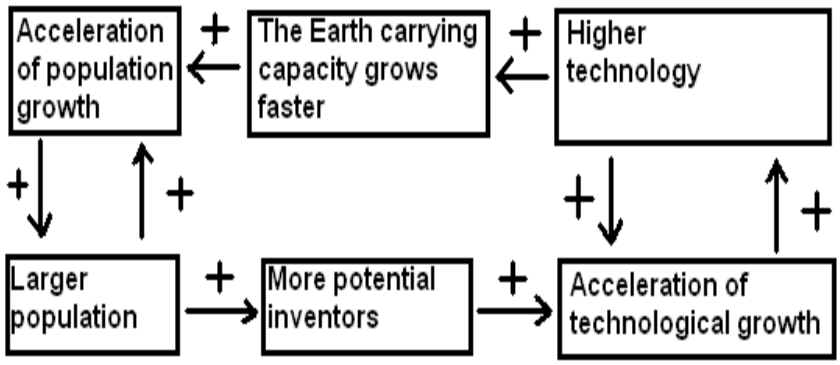
NOTES: $R = 0.998$, $R^2 = 0.996$, $p << 0.0001$. Black markers correspond to empirical estimates of Modelski (2003), Gruebler (2006) and UN Population Division (2006). The solid grey curve was generated by the following equation:

$$U_t = \frac{7705000}{(2047-t)^2}.$$

Parameters C (7705000) and t_0 (2047) have been calculated with the least squares method.

The observed very high level of correlation between the long-term macrodynamics of the world urban population and the dynamics generated by the quadratic-hyperbolic model does not seem coincidental at all and is accounted for by the presence of second-order nonlinear positive feedback loops between the world's demographic growth and the World System technological development that can be spelled out as follows: the more people – the more potential inventors – the faster technological growth – the faster growth of the Earth's carrying capacity – the faster population growth – with more people you also have more potential inventors – hence, faster technological growth, and so on (Kuznets 1960; Simon 1977, 1981, 2000; Grossman and Helpman 1991; Aghion and Howitt 1992, 1998; Jones 1995, 2003, 2005; Kremer 1993; Cohen, 1995; Komlos and Nefedov 2002; Подлазов 2000, 2001, 2002; Podlazov, 2004; Tsirel 2004; Коротаев, Малков, Халтурина 2005, 2006; Korotayev, Malkov, and Khaltourina 2006a, 2006b) (see Diagram 3):

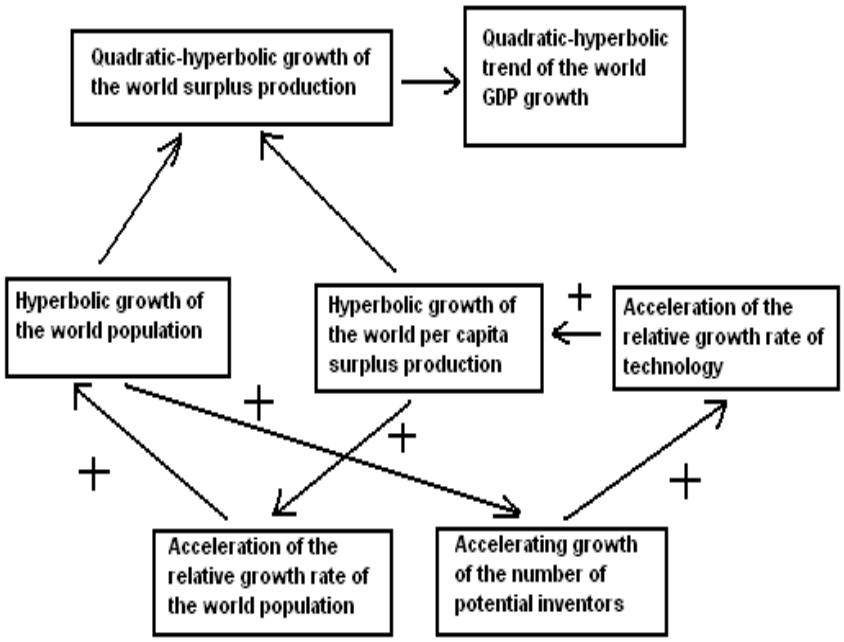
Diagram 3. Block Scheme of the Nonlinear Second Order Positive Feedback between Technological Development and Demographic Growth



As our (both mathematical and empirical) analysis (see, *e.g.*, Коротаев, Малков, Халтурина 2005a, 2005b; Korotayev, Malkov, and Khaltourina 2006a) suggests, up to the 1970s the above mentioned mechanism tended to lead not only to the hyperbolic growth of the World System population, but also to the hyperbolic growth of the per capita surplus[3] and also to the quadratic-hyperbolic growth of the world GDP (see Diagram 4):

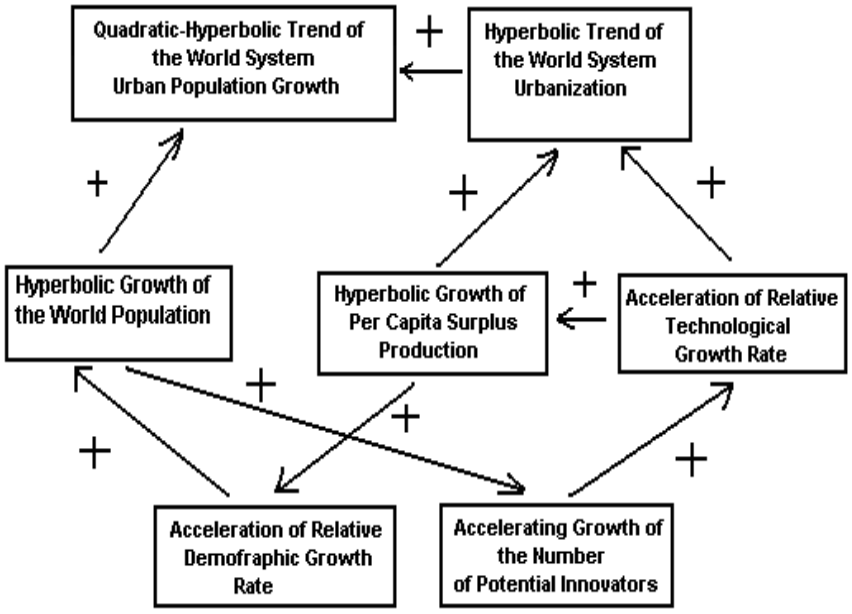
[3] That is, the product produced, per person, over the amount (*m*) minimally necessary to reproduce the population with a zero growth rate in a Malthusian system.

Diagram 4. Block Scheme of the Nonlinear Second Order Positive Feedback between Technological Development, Demographic and Economic Growth



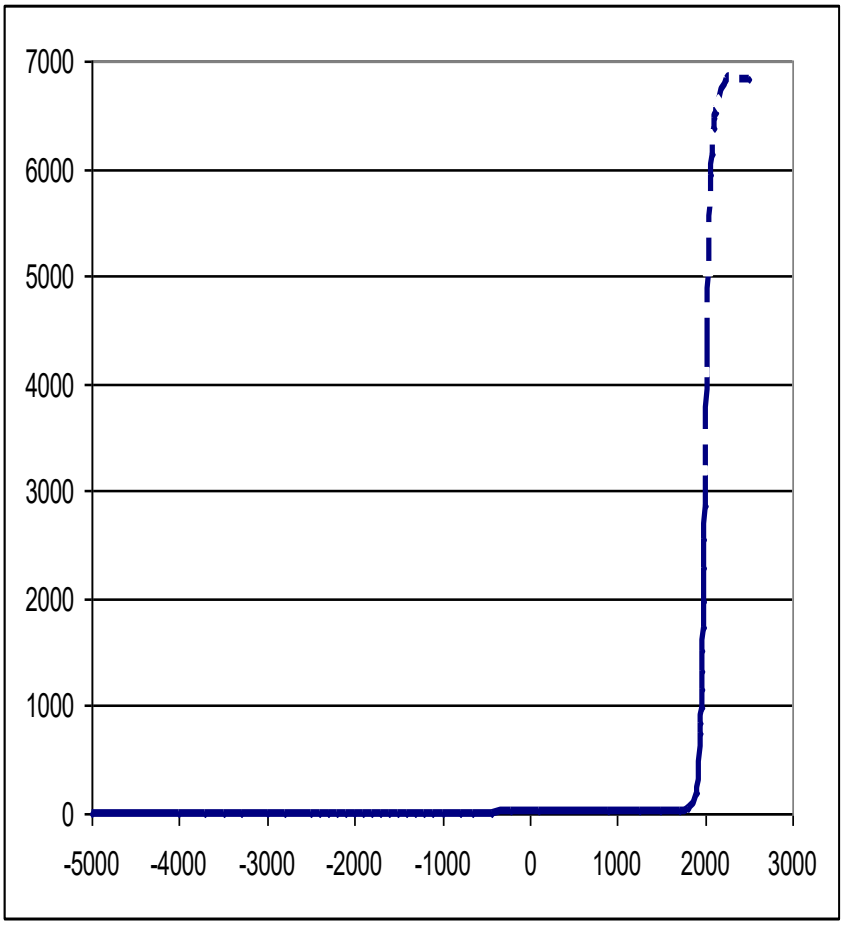
Up to the 1970s – 1990s the trend towards the hyperbolic growth of the per capita surplus production (in conjunction with the hyperbolic acceleration of the technological growth) tended to result in the trend towards the hyperbolic growth in world urbanization (that is, the hyperbolic growth of the proportion of the urban population in the total population of the world); in conjunction with the hyperbolic growth of the world's population this, naturally, also produced a long-term trend towards the quadratic-hyperbolic growth of the world urban population (see Diagram 5):

Diagram 5. Block Scheme of the Nonlinear Second Order Positive Feedback Generating the Trend towards the Quadratic-Hyperbolic Growth of the World System Urban Population



The best fit of the dynamics generated by the quadratic-hyperbolic equation (1) to the empirical estimates of the world urban population is observed for the period prior to 1965. For this period, equation (1) describes more than 99.88% of all the macrovariation of the variable in question ($R = 0.9994$, $R^2 = 0.9988$, with the following parameter values: $C = 2610000$ [in millions], $t_0 = 2010$). Incidentally, the above mentioned parameter value ($t_0 = 2010$ [CE]) indicates that if the world urban population growth trend observed prior to the mid 1960s continued, the world urban population would become infinite already in 2010. That is why, it is hardly surprising that since the mid 1960s the World System started its withdrawal from the blow-up regime with respect to the variable in question. Indeed, since the 1960s we observe the slow-down of the relative rate of the world urban population growth, and, according to the forecasts (see, *e.g.*, Gruebler 2006) in the forthcoming decades the slow-down of the absolute rates of the world population growth will also start, resulting in the stabilization of the world urban population in the 22nd century at the level of about 7 billion (see Diagram 6):

Diagram 6. World Urban Population Dynamics (in millions), for cities with >10000 inhabitants (5000 BCE– 2006 CE), with a forecast till 2350



NOTES. Data sources: Modelski 2003; Gruebler 2006; UN Population Division 2006. The curve for 2006–2350 has been calculated on the basis of Gruebler's medium forecast for the dynamics of the world urbanization (*i.e.*, the proportion of the urban population in the overall population of the world) and our own forecast of the world population for this period (Korotayev, Malkov, Khaltourina 2006a).

The general macrodynamics of the World System urbanization can be described mathematically with the following differential equation:

$$\frac{du}{dt} = aSu(u_{\lim} - u) , \quad (2)$$

where u is the proportion of the population that is urban, S is per capita surplus produced with the given level of the World System's technological development, a is a constant, and $u_{\lim}$ is the maximum possible proportion of the population that can be urban (that may be estimated as being within 0.8–0.9, and can be regarded within the given context as the "saturation level").

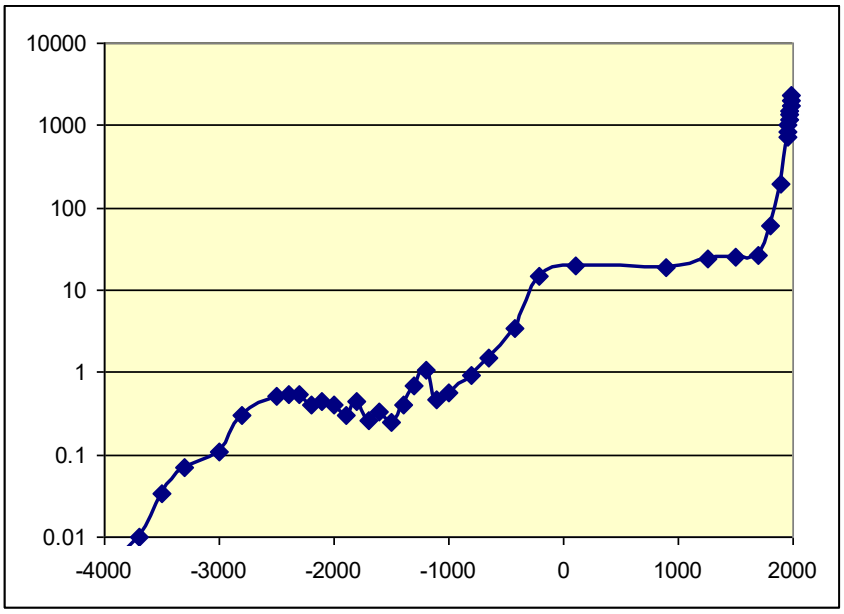
With low values of u (< 0.3) its dynamics is determined first of all by the hyperbolic growth of S,[4] as a result of which the urbanization dynamics turn out to be also close to the hyperbolic dynamics, which, in conjunction with the hyperbolic growth of the World System population (that was naturally observed just for the period characterized by low values of the world urbanization) led to the fact that the overall macrodynamics of the world urban population for this period was described very well by the quadratic-hyperbolic equation. With higher values of the world urbanization index (u) the saturation effect begins being felt more and more strongly, and as it approaches saturation level the world urbanization growth rates begin to slow down more and more, which is observed at present – a time when the World System has begun its withdrawal from the blow-up regime.

It is difficult not to notice that the history of world urbanization up to the 19th century looks, in Diagrams 1–2 and 6, extremely "dull", producing an impression of an almost perfect stagnation[5] followed by explosive modern urban population growth. In reality the latter just does not let us discern, in the diagrams above, the fact that many stretches of the pre-modern world urban history were characterized by dynamics that were comparatively no less dramatic. In fact, the impression of the pre-modern urban stagnation created by diagrams above could be regarded as an illusion (in the strict sense of this word) produced just by the quadratic-hyperbolic trend of the world urban population growth observed up to the mid 1960s. To see this it is sufficient to consider Diagram 1 in a logarithmic scale (see Diagram 7):

[4] For the systems of equations describing this hyperbolic growth generated by the second-order nonlinear positive feedback loops between the World System technological development and the world demographic growth see, *e.g.*, Korotayev, Malkov, and Khaltourina 2006a, 2006b.

[5] Whereas for the period prior to 1000 BCE this stagnation looks absolute.

Diagram 7. Dynamics of the World Urban Population (in millions), for cities with >10000 inhabitants (5000 г. до н.э. – 1990 г. н.э.), LOGARITHMIC SCALE

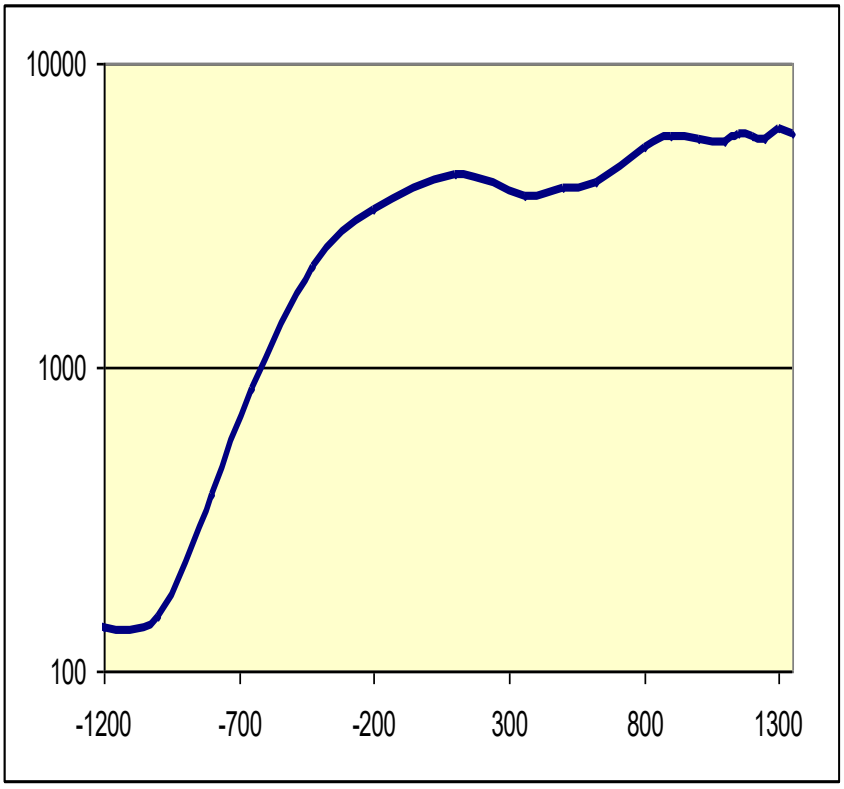


As we see, the structure of the curve of the World System urban population growth turns out to be much more complex than one would imagine at first glance at Diagrams 1–2 and 6. First of all, one can single out in a rather distinct way three periods of relatively fast world urban population growth: (A1) the second half of the 4th millennium BCE – the first half of the 3rd millennium BCE, (A2) the 1st millennium BCE and (A3) the 19th – 21st centuries CE. In addition to this, one can see two periods of relatively slow growth of the world urban population: (B1) the mid 3rd millennium BCE – the late 2nd millennium BCE and (B2) the 1st – 18th centuries CE. As we shall see below, two other periods turn out to be essentially close to these epochs: Period (B0) immediately preceding the mid 4th millennium (when the world urban population did not grow simply because the cities had not appeared yet and no cities existed on the Earth), and Period (B3) that is expected to begin in the 22nd century, when, according to forecasts, the world urban population will stop again to grow in any significant way (in connection with the World System urbanization reaching the saturation level and the stabilization of the world population) (see, *e.g.*, Gruebler 2006; Korotayev, Malkov, and Khaltourina 2006a, 2006b).

As one can see at Diagram 7, in Period B1 (from the mid 3rd millennium BCE to the early 1st millennium BCE) the world urban population fluctuated at the level reached by the end of the previous period (A1), whereas the trend dynamics carved its way with great difficulties through the dominant cyclical and stochastic dynamics (see, *e.g.*, Modelski 2003; Frank and Thompson 2005; Harper 2007). In Diagram 7 one could hardly discern the cyclical component of the world urban population dynamics during Period B2 (the 1st – 18th centuries CE), which is accounted for by the simple fact that the respective stretch of the diagram has been prepared on the basis of Gruebler's database that provides for this period a very small number of data points that is not sufficient for the detection of the cyclical component of the process under study. Within Period B2 this cyclical component will be more visible if we use Chandler's database, which provides much more data points for this period (Chandler 1987: 460–510)[6] (see Diagram 8):

[6] This database consists of lists of the largest cities of the world for various time points with estimates of the respective cities' population for respective moments of time. Chandler provides estimates for the following time points (numbers in brackets indicate the urban population in thousands, for cities with population not smaller than which the estimates are provided for the respective year; for example, number 20 in brackets after 800 BCE indicates that for 800 BCE Chandler's database provides estimates of the urban population for all the world cities with no less than 20 thousand inhabitants) – 2250 BCE (20), 2000 BCE (20), 1800 BCE (20), 1600 BCE (20), 1360 BCE (20), 1200 BCE (20), 1000 BCE (20), 800 BCE (20), 650 BCE (30), 430 BCE (30), 200 BCE (30) and further for the following years CE: 100 (30), 361 (40), 500 (40), 622 (40), 800 (40), 900 (40), 1000 (40), 1100 (40), 1150 (40), 1200 (40), 1250 (40), 1300 (40), 1350 (40), 1400 (45), 1450 (45), 1500 (45), 1550 (50), 1575 (50), 1600 (60), 1650 (58), 1700 (60), 1750 (68), 1800 (20), 1825 (90), 1850 (116), 1875 (192), 1900 (30), 1914 (455), 1925 (200), 1950 (200) and 1970 (1930). The main problem with the use of Chandler's database within the context of the present study is that it turns out to be impossible to get data on the world urban population dynamics through the simple summation of the populations of the cities covered by Chandler for the respective years. Indeed, with such a simple summation we will obtain, for example, for 1825 a figure indicating the total urban population that lived in that year in cities with no less than 90 thousand inhabitants, for 1850 – for the cities with no less than 116 thousand inhabitants, for 1875 – for the cities with no less than 192 thousand inhabitants, for 1900 – for the cities with no less than 30 thousand inhabitants, for 1914 – for the cities with no less than 455 thousand inhabitants; and such a series of numbers will not supply us with any useful information. On the other hand, of course, if for one year we have at our disposal data on cities with >80 thousand inhabitants, for a second – on cities with >120 thousand, and for a third – on cities with >100 thousand, we can trace the urban population dynamics for cities with >120 thousand inhabitants. However, this does not solve the whole problem. Indeed, when we use Chandler's database with respect to the last centuries, we can only obtain a meaningful dynamic time series for the megacities (>200 thousand inhabitants). However, even with this approach we cannot obtain a general picture of the world urban population dynamics for the whole period covered by Chandler's database (that is, since 2250 BCE), as no such megacities existed before the mid 1st millennium BCE. The longest dynamic time series can be here obtained for the cities with no less than 40 thousand inhabitants (especially in conjunction with Modelski's database). However, in this case we cannot move after 1350 CE. Because of this, when using Chandler's database we will have to utilize the data on the total population of large cities (with no less than 40 thousand inhabitants) for the period between 3300 BCE and 1350 CE (in conjunction with Modelski's data on the period before 2250 BCE)

Diagram 8. Urban Population Dynamics (in thousands), for cities with no less than 40,000 inhabitants (1200 BCE – 1350 CE), logarithmic scale

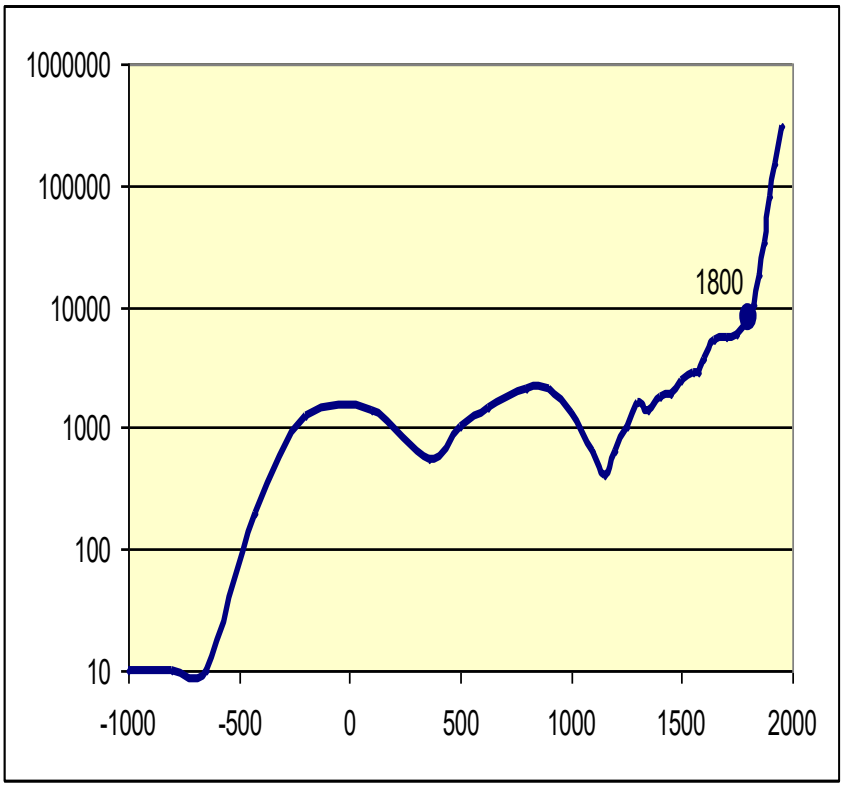


As we see, at this diagram we can observe for Period B2 not only a distinct cyclical component[7], but also a more clear upward trend. This trend will be even more distinctly visible if we plot Chandler's data on population dynamics of megacity (>200,000) inhabitants (which will also make it possible for us to take into account the period after 1350) (see Diagram 9):

and data on the total population of megacities (with no less than 200 thousand inhabitants each) for the period between 430 BCE and 1950 CE.

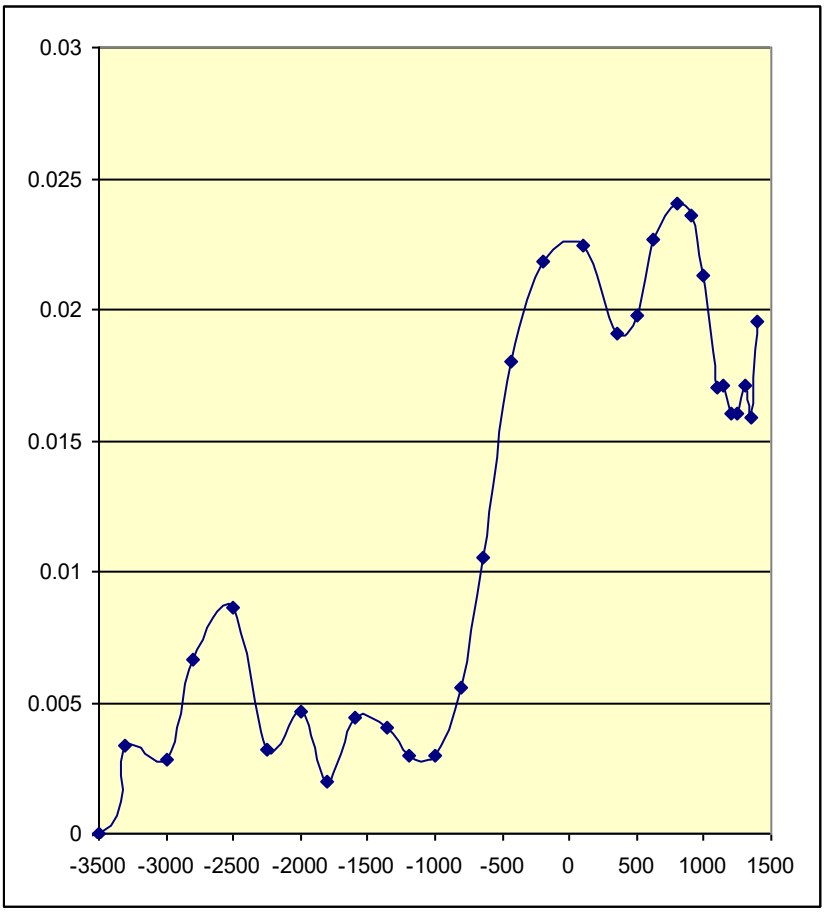
[7] In particular after 1100, which is connected with the point that in Chandler's database after this year the distance between data points get reduced from 100 to 50 years.

Diagram 9. World Urban Population Dynamics (in thousands), for cities with no less than 200,000 inhabitants (1000 BCE – 1950 CE), logarithmic scale



As we see, a steady upward trend can be traced here for a few centuries before 1800. On the other hand, one should take into account the point that a relatively fast growth of the world urban population was observed during this period against the background of the hyperbolically accelerating growth of the overall population of the world (see, *e.g.*, Korotayev, Malkov, and Khaltourina 2006a, 2006b). That is why we shall obtain a clearer picture of the world urbanization dynamics if we plot the estimates of the dynamics of the world urbanization index *per se*, that is the proportion of the urban population in the overall population of the world (see Diagram 10):

Diagram 10. Dynamics of the World Macrourbanization Index (proportion of population living in large, >40000 inhabitants) according to the estimates of Modelski and Chandler (3500 BCE – 1400 CE)

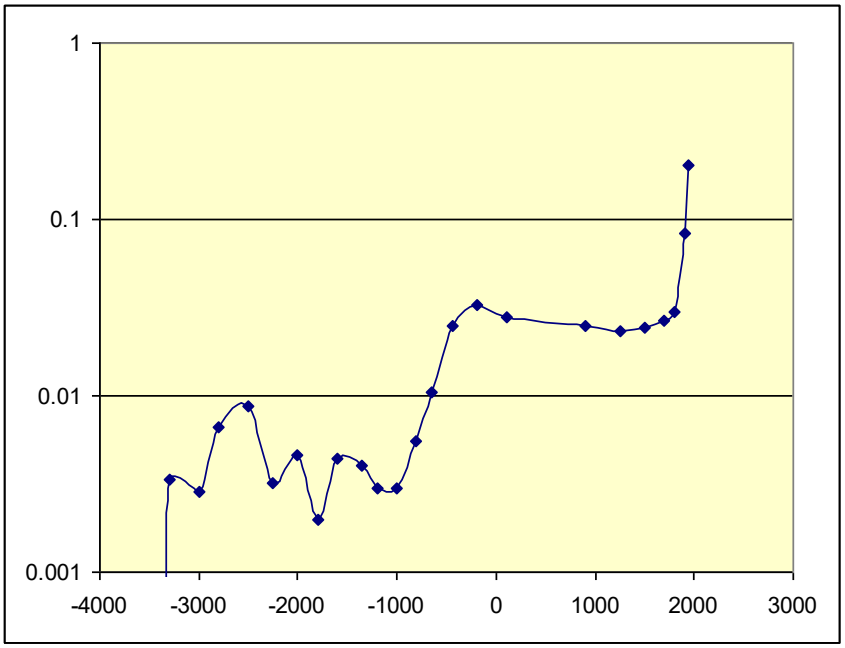


As has been mentioned above, Chandler's database does not make it possible to trace the world macrourbanization dynamics after 1400.[8] That is why in order to obtain an overall picture of the world urbanization dynamics we shall have to rely with respect to Period B2 on Gruebler's estimates (incidentally, let us recollect that because of a very small number of data points in this database the re-

[8] In fact, it produces a bit of a distorted picture already for 1400, as for this year it contains data on the cities with >45 (and not 40) thousand inhabitants.

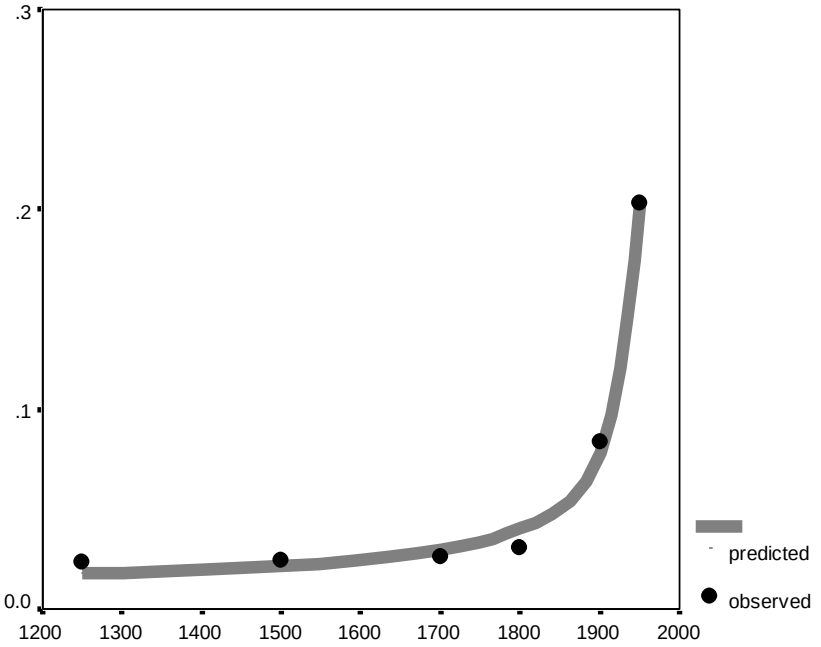
spective graphs do not reflect the cyclical component of the world macro-urbanization dynamics):

Diagram 11. Dynamics of the World Macrourbanization (proportion of population living in large, >40,000, cities in the overall population of the world) according to the databases of Modelski, Chandler, and Gruebler (4000 BCE – 1950 CE), logarithmic scale



Our analysis suggests some idea of the general picture of the long-term macro-urbanization of the world. During Period A1 we observe the formation of the first large cities, and the proportion of their population reached the level of decimals of one per cent of the overall population of the world. During Period B1 this variable had fluctuated within this order of magnitude until, during Period A2, it moved to the further order of magnitude, to the level of more than one per cent. The variable in question had fluctuated within this order of magnitude during Period B2 until, during Period A3, it began its movement to the next (and, note, the last possible) order of magnitude, to the level of dozens per cent. It is also remarkable that for the 2nd millennium CE Gruebler's database indicates a clear hyperbolic trend of the world macro-urbanization described mathematically by model (2) (see Diagram 12):

Diagram 12. World Macrourbanization Dynamics, 1250–1950 CE: correlation between predictions of the hyperbolic model and empirical estimates



NOTES: R = 0.997, R^2 = 0.994, p < 0.0001. The black markers correspond to Gruebler's (2006) empirical estimates. The solid grey curve has been generated by the following equation:

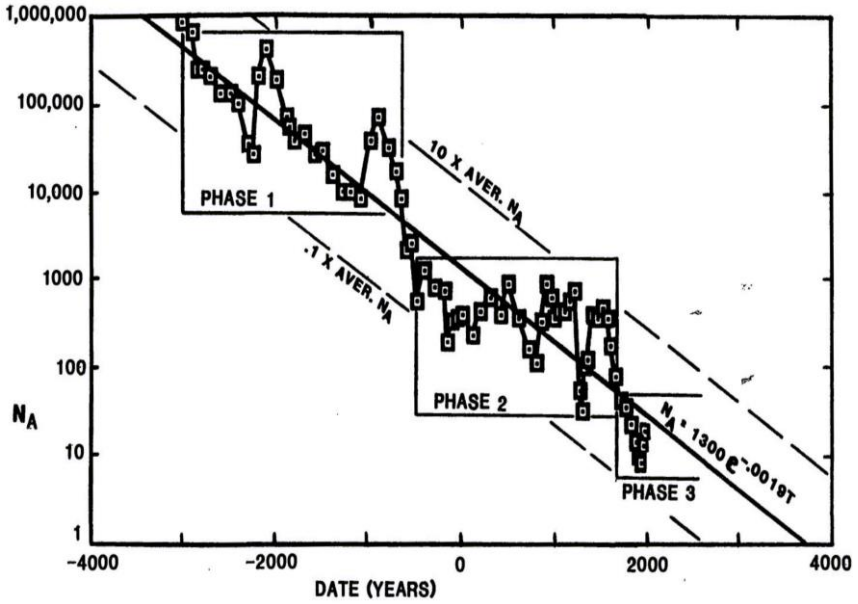
$$u_t = 0{,}01067 + \frac{5.203}{(1977 - t)}.$$

Parameters C (5,203), t_0 (1977) and the constant (0,01067) have been calculated with the least squares method.

Note that the detected world urbanization dynamics correlates rather well with the dynamics of the World System political organization (see the article by Grinin and Korotayev in the present issue of the Almanac). Note also that the above mentioned synchronous phase transitions to the new orders of magnitude of the world urbanization and new order of the World System political organization complexity coincide in time with phase transitions to higher orders of the World System political centralization that were detected by Taagapera and that took place, according to his calculations, during periods A1, A2 и A3. Taagap-

era estimates the World System political centralization dynamics using the indicator that he denotes as an "effective number of polities" that is a reverse of the political centralization index (which has values between 0 and 1, where 1 corresponds to the maximum level of the world political centralization, that is the world unification within one polity). Thus, in Diagram 13 below, the downward trend corresponds to the GROWTH of political centralization of the world:

Diagram 13. Dynamics of the "Effective Number of Polities" Calculated on the Basis of Territory Size Controlled by Various Polities (Taagapera 1997: 485, Fig. 4)



Similar phase transitions appear to be observed with respect to the world literacy macrodynamics. Indeed, during Period A1 we observe the appearance of the first literate people whose proportion had reached the level of decimals of one per cent by the end of this period and fluctuated at this level during Period B1. During Period A2. world literacy grew by an order of magnitude and reached the level of several per cent of the total population of the world, it fluctuated at this level during Period B2 till the late 18th century when Period A3 started; during this period the world literacy has reached the level of dozens per cent, and by the beginning of Period B3 (presumably in the 22nd century) it is likely

to stabilize at the 100% level (see, *e.g.*, Дьяконов 1994; Мельянцев 1996; Korotayev, Malkov, and Khaltourina 2006a).

In fact, the above mentioned phase transitions can be regarded as different aspects of a series of unified phase transitions: Phase Transition A1 from medium complexity agrarian societies to complex agrarian ones, Phase Transition A2 from complex agrarian societies to supercomplex ones, and, finally, Phase Transition A3 from supercomplex agrarian societies to postindustrial ones (within this perspective, the period of industrial societies turns out to be a period of phase transition B2 – B3).

* * *

Thus, the World System history from the 6th millennium BCE can be described as a movement from Attraction Basin B0 (the one of medium complexity agrarian society) through Phase Transition A1 to Attraction Basin B1 (the one of complex agrarian society), and further through Phase Transition A2 to Attraction Basin B2 (the one of supercomplex agrarian society), and further through Phase Transition A3 to Attraction Basin B3 (the one of postindustrial society). Note that within this perspective the industrial period turns out to be a period of phase transition from the preindustrial society to the postindustrial one.

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Political Development of the World System: A Formal Quantitative Analysis[1]

Leonid Grinin and Andrey Korotayev

As the main evolving political unit of the World System is the state, it becomes necessary to begin our article with a discussion of the relevant set of definitions regarding the evolutionary sequence of state types.[2] Some scholars are "suspicious" to the very idea of identifying stages within any processes; in fact, it is not unusual for them to directly contrast the notion of "process" with "stages" as mutually exclusive (see, *e.g.*, Shanks and Tilley 1987; see also Marcus and Feinman 1998: 3; Штомпка 1996: 238). However, we agree with Carneiro (2000b) that the opposition of process to stages is a false dichotomy, as stages are nothing else but continuous episodes of a continuous process, whereas the notion of process can be used for the development of the notion of stages (Goudsblom 1996; see also Гринин 2006в).

When the development of statehood in the framework of the overall historical process is analyzed, two main stages are usually identified: the ones of the **early** state and those of the **mature** state (see, for example, Claessen and Skalník 1978a; Claessen and van de Velde 1987, 1991; Skalník 1996; Shifferd 1987; Tymosski 1987; Кочакова 1995). However, when we try to apply this scheme to the political development of the World System, it becomes evident that in no way is this scheme complete.

Firstly, if, according to the prevalent views, the first mature states appeared in ancient times (Egypt), or in the late 1st millennium BCE (China)[3], how could we classify the European states of the 18th and 19th centuries, let alone the contemporary states? Would they be also mature, or supermature?

Secondly, it is evident that the European 19th century states also differed in the most profound way from the complex politically centralized monarchies of

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[2] Within the framework of this article *the state is defined as a category that denotes a system of specialized institutions, organs, and norms that support internal and external life of a society; an organization of power, administration, and order- maintenance that possesses the following characteristics: (a) sovereignty (autonomy); (b) supremacy, legitimacy and reality of power within a certain territory and a certain circle of people; (c) has the capability to coerce people to fulfill its demands, as well as to change relations and norms.*

[3] For example, in the *Early State* (Claessen, Skalník 1978d) contributions dealing with Egypt and China (Janssen 1978: 213; Pokora 1978: 198–199) the period of the early state corresponds to the Ancient Kingdom (up to 2150 BCE), whereas for China it is regarded as the period preceding the formation of the Qin Empire (up to 221 BCE).

the Antiquity and Middle Ages (which themselves are qualitatively more complex than the early state) according to a number of other characteristics (in particular, with respect to the administration level and culture, the level of development of the law, and the relationships between the state and society). This accounts for the following statement by Max Weber: "In fact, the State itself, in the sense of a political association with a rational, written constitution, rationally ordained law, and an administration bound to rational rules or laws, administered by trained officials, is known, in this combination of characteristics, only in the Occident, despite all other approaches to it" (Weber 1958: 15–16)[4].

Thirdly, it would be rather strange to assume that the industrial revolution of the 18th and 19th century did not lead to the radical transformation of the state organization, whereas the scheme *early state – mature state* does not reflect this transformation at all.

Thus, it is rather clear that Claessen and Skalník (1978b: 5) had restricted their scheme of the statehood development to the *pre-capitalist non-industrial* states only. Consequently, the first author of this article has suggested to significantly augment and amend the theory of the *early – mature* state (see Гринин 2006а, 2006б, 2006г, 2006е), and has come to the conclusion about the necessity to "insert" between the early and mature state a stage of the **developed statehood.** Hence, we are dealing not with the two main stages of statehood development (the early states and the mature states), but with following three stages:

а) **early states** that are not sufficiently centralized yet and that politically organize societies with underdeveloped social, class (and, frequently, administrative-political) structures;

б) **developed states**, these are the formed centralized states of Late Antiquity, the Middle Ages, and the Early Modern period, and politically organize societies with distinct estate-class stratification;

в) **the mature states** of the capitalist epoch that organize politically such societies, in which estates have disappeared, the bourgeois and working classes have formed, nations have developed, and representative democracy has proliferated.[5] To be more correct we should speak about Industrial, rather than capitalist period, as this group includes industrial socialist states. This has made it necessary to develop anew the statehood evolution theory and to suggest new

[4] Some scholars even believe that one only can speak about the real states starting from Early Modern Europe, since the 15th and 16th centuries (see, *e.g.*, Белков 1995: 178–182). Vincent (1987) also prefers to speak about the *states* only since the 16th century. There are a number of other scholars who prefer to stick to the same position (see on this, *e.g.*, van der Vliet 2005).

[5] Correspondingly **early, developed, and mature** states could be denoted as **simple, complex, and supercomplex**. Note that this terminology would correspond to the one suggested for the evolutionary typology of chiefdoms that are also subdivided into simple, complex, and supercomplex ones (see, *e.g.*, Korotayev *et al.* 2000; Kradin 2000). Note also that these three types of states are actually characterized by three different orders of magnitude of complexity as it is understood in Complexity Studies (see, *e.g.*, Lewin 1992; Waldrop 1992).

formulations of the main characteristics of each of the stages of this evolutionary process (see Гринин 2006а, 2006б, 2006г, 2006е).

For each stage we can identify three phases: the *primitive, typical, and transitional states of each respective type*[6]. In the framework of this article the basic characteristics of statehood stages are identified on the basis of the middle phase of each stage (thus, respectively for *typical* early, *typical* developed, and *typical* mature states). The point is that at the first phase (the one of the *primitive* state of the respective type) the polity retains many elements of the previous state type, whereas in the third phase (the *transitional* phase) many of its institutions become "overripe" and the first characteristics of a higher stage of the statehood development appear.

Main differences between the early, developed, and mature states

Early states differ greatly among themselves according to many characteristics, in particular with respect to the degree of their centralization, as well as the level of development of their administrative, taxation, and judicial systems. However, if we look for what differentiates them from the developed and mature states, we will find that the **early state** is always an **incomplete state (both organizationally and socially).** This "incompleteness" is also relevant with respect to relationships between the state and the society. There were numerous versions of the early states, but within each of them some important elements of statehood were either absent, or significantly underdeveloped. In most cases this incompleteness was expressed in the most direct way, as most of the early states simply did not have some significant statehood attributes, or did not develop them to a sufficient degree. First of all, this is relevant with respect to such statehood attributes as *professional administration, control and repression apparatus, taxation, territorial division, as well as a sufficiently high degree of centralization and written law*. However, in some early states (such as, for example, the state of the Incas or the Early Kingdom in Egypt) a contrary disproportion is observed. Though the administrative apparatus and bureaucracy were rather powerful there, they were imposed upon societies that were underdeveloped socially and/or ethnically. Hence, in such cases it was the *society* that looked underdeveloped in comparison with the state.

[6] In general, these names are given to the respective phases in accordance with the tradition of Claessen and Skalník (1978b: 22–23; 1978c: 640; Claessen 1978: 589) who identified the inchoate, typical, and transitional stages of the early state. However, there are certain problems when we deal with a regression from a developed to a primitive phase of certain types of statehood. For example, to denote the 18th century developed state in Egypt (after it had regressed from the typical developed statehood found there, *e.g.*, in the 16th, or 11th centuries) as "inchoate" appears to be clearly misleading (see, *e.g.*, Гринин 2006ж). Hence, the term "primitive" seems to be more appropriate here.

The **developed state** is a state that has been **formed and completed, and centralized**, that has all the above mentioned attributes of statehood (among them the professional apparatus of administration and control, regular taxation and artificial territorial division). Thus, the statehood attributes that could be absent within the political system of the early state are necessarily present within the one of the developed state[7]. The developed state was a result of a long historical development and selection, as a result of which those states turn out to be more successful whose institutes are organically linked with the social structures of respective societies that are both grounded on the respective social order and support it. For example, in Russia such states with effective centralization developed on the basis of the formation of the estate society, estate monarchy, the alliance between the monarchs and nobility (and sometimes with cities). The developed state influences social processes in a much more purposeful and active way. It is not only tightly connected with the peculiarities of social and corporate structure of the society, but also constructs them in political and judicial institutes. In this respect it can be regarded as an **estate-corporate** state. Naturally, different states reached the respective stage of their development in different times (see Table 1 for more detail).

The **mature state** is a result of capitalist development and the industrial revolution; hence, it has a qualitatively different production basis. Other differences between the mature state and its predecessors are also very significant. It is bases on a formed or forming nation with all its peculiarities. Such a state is qualitatively more developed in organizational and legal respects, it always has a professional bureaucracy with its definite characteristics (see, *e.g.*, Weber 1947: 333–334), and a clear mechanism of power transmission and rotation. It is also natural that the mature state has qualitatively more developed and specialized institutions of administration and control. The mature state was also gradually transformed from an estate-class state into a purely class one; and in its final stages it evolves into a social state. Thus, **in the Antiquity and Middle Ages there were no mature states, but only early and developed ones**. The first mature states could only appear in the late 17th and 18th centuries.

The above mentioned evolutionary types of states differ among themselves by a number of other characteristics. In particular, it appears necessary to pay attention to these differences with respect to the interaction between *centralized*

[7] Naturally, the notion of *"developed"* state is rather conventional. It can only be regarded as developed in comparison with the less complex ("early") state, whereas it appears underdeveloped when compared with the more complex ("mature") statehood. Thus the Russian state in the age of Ivan the Terrible appears rather developed when compared with the Muscovy Princedom of Ivan Kalita and his successors. However, it does not stand any comparison even with the empire of Peter the Great. However, the state of Peter I looks rather primitive in comparison with, say, the Russian Empire in the late 19th century. To denote the three stages of the statehood evolution one may also use the terminology (mentioned in note 5 above) suggested by the second author of this article: the simple (early) state – the complex (developed) state – the supercomplex (mature) state. However, this terminology also has its own limitations.

power, the elite, and the commoners ("population"). This point that is important by itself acquires an especial theoretical significance, because the interaction model of *state – elite – commoners* is used rather productively in the demographic-structural theory that analyzes the dynamics of internal processes in preindustrial and early industrial societies, as well as the interaction between the elements of this structure in conditions of population growth and the resource deficits produced by this growth (see, *e.g.*, Goldstone 1991; Turchin 2003, 2005a; Нефедов 2005; Korotayev and Khaltourina 2006).

In the present article, the model of interaction for the triangle CENTER – ELITE – COMMONERS (PEOPLE) within each evolutionary type of state can be only presented as short descriptions of the most typical situations (see Гринин 2006a for more detail)[8]. These schemes look as follows.[9]

In **the early state** we frequently observe a situation where the elites, basing themselves on their resources (lands, clients, military force) or their special position (as recognized representatives of certain lineages or dynasties, heads of tribal formations and so on), control, in some way or another, a very large part of the territory of a respective country, or even most of it. The commoners find themselves under the jurisdiction and effective control of the elites and they are required to perform state duties. A considerable part of the commoner population (especially serfs, slaves and so on) find themselves altogether out of the state's jurisdiction. Within such situations the center turns out to be actually an aggregate of the forces of the elites (both regional elites and the ones represented in the capital). Frequently the center cannot organize the main functions of the state without the elites, because the state does not possess yet the necessary apparatus, or this apparatus is rather weak. Thus, **the interrelations between the commoner population and the center are mediated by the elites to a very considerable degree.** As a result, the elites take control of the territorial-functional institutions, in particular the fixation of duties, tax collection, judiciary, organization of military forces and defense, land distribution (this is frequently combined with the elites' immunity and autonomy as a sort of payment for the performance of such functions). We can mention as examples of such early states the feudal states of Europe, such as the Frankish state in the 8^{th} – 10^{th} centuries, England (both before the Norman conquest and some time after it), German states in the 10^{th} – 15^{th} centuries, Kievan Russia and Muscovy up to the age of Ivan III. This is typical for many ancient and medieval states outside Europe (for example, for Mesopotamia after Hammurabi, for the Hittite

[8] The analysis of other (by far less typical) models of the interaction between the center, the elites, and the populace in the early, developed, and mature states goes beyond the scope of the present article.

[9] Some of the points presented below have found further elaboration in Malkov's article in the Russian version of this Almanac.

Kingdom, for Chou China, considerable parts of the Japanese history, and so on).[10]

In **the developed state** the elites are significantly more integrated in the state system, thus they are much more connected to the center. In comparison with the early state, the developed state possesses a considerably larger and much more sophisticated administration apparatus. However, it is only represented systematically in the center, whereas at the periphery it is rather fragmentary. That is why here the elites still act as a component of the regional state apparatus, especially with respect to the military functions, but also frequently with regards to general administration, taxation, judiciary, religious subsystem and so on (see, *e.g.*, note 41). In particular, large landowners frequently performed taxation, judiciary and administrative functions; the taxes were collected by tax-farmers and the police functions would be performed by representatives of special social groups (for example, in the Ottoman provinces they were performed by the Janissaries [see, *e.g.*, Kimche 1968: 455]).

This point does not contradict the idea that the developed state is more organically connected with the society than the early one does. Within the developed state the relations between the center and the commoners are **both direct and indirect**, that is, they are partly mediated by the elites, but partly these relations are conducted directly through the formal and official **local** state apparatus. In the meantime the commoners rely more and more on the center as a possible protector against the arbitrariness of the local elites, which is much less typical for the early state.

In **the mature state** its administrative-bureaucratic apparatus becomes quite systemic and complete, which makes it possible for the center to conduct its interaction with the commoner population directly. In the mature state it appears more accurate to speak about the interrelations between the elites, the populace, and the *state* (rather than the *center*). We observe the relationships between the state and the elite becoming **civil**. This means that the elites (that is, large-scale landowners, businessmen, financiers, as well as the intellectuals' elite) stop performing the direct functions of the state structures, these functions are now performed almost entirely by the formal, official state organs; that is, the elites can be regarded as a part of the civil society, no longer as a part of the state. However, the elites' privileges and status are still protected by the state. All these contribute to the formation of civil society. **The relationships between the state and the populace are direct and immediate** both through the state apparatus (for example, through taxation or judicial organs), and through the participation of the populace in elections.

[10] Even in the early states with a relatively strong center we observe frequently a situation described by Claessen and Oosten (1996): "The ruler and the elite in the centre favour centralization and the establishment and maintenance of centralized power, while local elites favour decentralization. In practice these efforts are frequently characterized by the pursuit of a 'balance of power' policy and competition for important offices, rather than by the dominance by the central ruler over the dignitaries of the state".

Summing up it may be said that in the early state the center only unites (quite weakly) the territories and populations through the mediation of the elites that provide most of the direct interaction with the populace; in the developed state the center directly or indirectly integrates the elites into the state apparatus, limits the elites' influence on the populace, establishes some direct relations with the populace; the mature state (with the help of a rather sophisticated administrative apparatus and elaborated legal system that it possesses) eliminates the administrative-territorial control of the elites over the populace, transforms the elites into a part of the civil society, and establishes systematic direct links between the state and the populace.

Political Evolution of the World System

As is well known, within the World System the first states appeared in the 4th and early 3rd millennia BCE (see, *e.g.*, Виноградов 2000: 150–151; Дьяконов 2000: 45–56; Baines and Yoffee 1998: 199; Wright 1977: 386; 1998), though the dates differ depending on various historical and archaeological reconstructions; of course, they also depend on the definition of the state used by different scholars. During the subsequent millennium and a half the main trend of the World System political evolution was connected with the transformation of non-state polities into the states or their parts (for more detail see the next article in this Almanac). However, to understand the real complexity of the World System political structure in this period it is necessary to take into account the presence (in addition to early states and pre-state polities) of **early state *analogues***, *i.e.*, polities that were comparable with early states according to their complexity and functions, but that differed from the state by some characteristics of their political and administrative organization[11]. Then, in the late 3rd mil-

[11] The first author of this article has suggested subdividing all the pre-state societies into two groups: the *structurally* pre-state societies, and the *historically* pre-state ones (Гринин 2001–2006; 2006а, 2006б, 2006д, 2006з; Grinin 2003, 2004c). The former are such societies that due to their current structural characteristics cannot get transformed directly even into the most primitive state under any conditions. The latter are such social systems that already possess the necessary characteristics (such as a sufficiently large size and a sufficiently high level of sociocultural complexity), that is why they can be transformed into a state under certain circumstances. However, when such circumstances are not available, they follow their own trajectories and become the **early state analogues.** The first author of this article believes that the early state differs from its analogues 1) by more complex administrative organization; 2) by more intensive transformational activity; 3) by its ability to coerce to fulfill its demands and to change social relations and norms being based on its own tasks and interests; 4) by its higher reliance on formal, judicial, administrative, that is, non-traditional bases; 5) the principles of recruitment for the state service could be different, but they were never restricted to a special position of a given person within the respective kinship network (for more detail see Grinin 2003, 2004a, 2004b, 2004c; Гринин 2006б, 2006в, 2006е). The second author of this article contends that those forms of complex political organization that were alternative to the state could be comparable with the early state (or even sometimes surpass it) according to almost all of the above mentioned characteristics, whereas the

lennium the World System political complexity increased even more. This is connected with the beginning of the transition to larger states, as well as to states of a new evolutionary type.

Within our systems of definitions, the first developed state (New Kingdom Egypt) appeared in the 16th century BCE.[12] However, its formation was preceded (as appears to also have been observed with respect to the early states) by the formation of the developed state analogue a few centuries before (see Table 1 below). The point is that with time some early states achieved such a high level of administrative development that, to a certain degree, they could be considered analogues (however incomplete) of the developed states. We mean such polities as the Third Dynasty of Ur state and the kingdom of Hammurabi in Mesopotamia. In addition to them the first complete analogues developed (for example, Middle Kingdom Egypt). Thus the first rise of the developed state and their analogues took place around the late 3rd millennium and the first half of the 2nd millennium BCE, which can be seen in Diagram 5 below and which corresponds to the first peak of World System urban population growth that is observed more or less in the same period (see the next article by the same authors in the present almanac).

However, for more than a millennium the early states remained absolutely dominant, whereas the forming developed state analogues turned out to be rather unstable. A new and much more sustained rise of the developed states was observed in the middle and second half of the 1st millennium BCE. Furthermore, by the early 1st millennium CE developed states and their analogues controlled a substantial proportion of the World System territory (and also the majority of the World System population lived just within this territory), as the developed states and their analogues included the largest polities of this period (the Achemenid Empire, the Ptolemaic and Seleucid states, the Qin and Han empires in China, the Roman, and later Byzantine, Empire, as well as the Sassanid Empire in Iran).[13] As we shall see in the next article of this almanac, the

only important difference was the presence of the professional administrative apparatus in the states and its absence in the states' alternatives (see, *e.g.*, Korotayev *et al*. 2000).

[12] Egypt possessed a few features that made it possible for the developed state to appear there earlier than in the other countries (though partial analogues of the developed state appeared in Mesopotamia already in the late 3rd millennium BCE). Firstly, this is the position of the Egyptian mainland as a narrow strip along one navigable river, the Nile. Secondly, this is a very high level of its ethnic and cultural homogeneity. Thirdly, this is a rather long period of absence of any significant external threat (and in this respect Egypt was very different from Mesopotamia). Fourthly, this is the presence of a strong ideology of royal power. Fifthly, this is the weakness of trade and money circulation, which strengthened the redistributive role of the state for a rather long period of time; however, later this point hindered significantly the further development.

[13] It appears necessary to stress that some states of the period in question that we classify as "early states" were actually at a rather high level of development and could be compared in some respects with the developed state analogues, or primitive developed states. This is accounted for by the fact that such early states were in the highest phase of this stage, that is, in the transitional early state phase when some elements of the developed state appeared (albeit in a fragmentary form). The fact that only a few early states managed to get transformed into developed ones was noticed

growth of the number of developed states and the expansion of the territory under their control correlate rather logically with the radical growth of the World System urban population observed within precisely the same period.

Table 1. Chronological Table of the Formation of the Developed States

#	*State*	*Note*	*Approximate date of the phase beginning*	*Marking event*	*Approximate date of the phase end*	*Marking event*
1.	Middle Kingdom Egypt	Analogue	-2000	Beginning of the 12th Dynasty	-1700	Beginning of the Second Intermediate Period
2.	New Kingdom and Late Pharaonic Egypt		-1580	Beginning of the 18th Dynasty	-525	Persian conquest of Egypt
3.	The Third Dynasty of Ur Sumer	Incomplete analogue	-2111	Beginning of Ur-Nammu's Reign	-2003	The fall of the Third Dynasty of Ur
4.	The Old Babylonian Kingdom	Incomplete analogue	-1792	Beginning of Hammurabi's Reign	-1595	The Kassite conquest of Babylonia
5.	The New Babylonian Kingdom	Analogue	-605	Beginning of Nebuchadnezzar the Great's Reign	- 539	Persian conquest of Babylonia
6.	The Achaemenid Empire	Analogue	- 518	Beginning of Darius' reforms	-330	Alexander's conquest
7.	Ptolemaic Egypt		-305	Ptolemy I Soter is proclaimed the king of Egypt	-30	Roman conquest of Egypt
8.	The Qin state in China	Analogue	-350s	Beginning of Shang Yang's reforms	-221	Formation of Qin Shi Huang's empire

long ago (this point will be discussed in more detail below). We believe that for early states the inability to get transformed into developed states was normal, whereas the ability to do so should be rather regarded as a positive exception. Within such circumstances, on the one hand, the development could continue; however, due to the enormous difficulty of the respective evolutionary breakthrough, such a development could acquire special forms, as a result of which such political systems could reach rather high levels of sociocultural complexity without being transformed into developed states. One of the most salient examples of political systems that overgrew significantly the level of a typical early state without being transformed into a developed state is represented by the Indian Maurya Empire that demonstrated a rather high level of administrative elaboration. This could be judged, for example, on the basis of data supplied by famous *Arthaśāstra* whose authorship is ascribed to Kautilya (traditionally identified with Chandragupta's [c.320–293 BCE] minister Chanakya). Though most indologists treat *Arthaśāstra*'s description of the Mauryan political system in a rather skeptical way (see, *e.g.*, Lelioukhine 2000), the question that we inevitably confront is how its author could give such a convincing description of so complex (and so adapted to the Indian conditions) a state organization if he had not seen anything comparable in reality. Other examples of such "overgrown" early states that did not manage to get transformed into the developed states are represented by a number of medieval polities of the early 2nd millennium CE, *e.g.*, the Khwarezmshahian Empire.

#	State	Note	Approximate date of the phase beginning	Marking event	Approximate date of the phase end	Marking event
9.	China		-221	Formation of the Qin Empire	the late 17th cent. – 1722	Transformation of China into a mature state analogue in the final period of Kangxi's reign
10.	The Seleucid State	Analogue	-305	Seleucus I Nicator assumes royal power	-64	Roman conquest of the remaining part of the Seleucid state
11.	Roman Empire		-30	Beginning of Octavianus Augustus' reign	476	Fall of the Western Roman Empire
12.	Byzantium		395	Division of the Roman Empire into the Western and Eastern ones	1453	Turk conquest of Constantinople
13.	Sassanid Iran		226/227	Coronation of the first Sassanid king, Ardashir I	633–651	Arab conquest of Iran
14.	Cambodia (Angkor)	Analogue	The early 11th century	Unification of the country by Suryavarman I	The late 13th century	The disintegration of the Khmer Empire
15.	The Abbasid Khalifate	Analogue	750	The Abbasid dynasty coming to power	945	The final lost of the real political power by the Abbasids
16.	The Umayyad Khalifate in Spain	Analogue	912	Beginning of `Abd al-Rahman III reign	1031	The final disintegration of the Khalifate, beginning of the epoch of leaders of small polities (*muluk al-tawa'if*)
17.	Arab Egypt	A part of the Ottoman Empire since 1525	969	The Fatimid conquest of Egypt and the transfer of the capital to Cairo	1922	Formal proclamation of the independence of Egypt
18.	The Delhi Sultanate	Analogue	1290	Beginning of the Khilji Dynasty	1398	Delhi sacked by Timur
19.	Japan		1392	Unification of dynasty, return of the capital to Kyoto	1868	Beginning of transformation of Japan into a mature state as a result of the "Meiji Restoration"
20.	Korea		1392	Beginning of the Li Dynasty	1945	Liberation of Korea from the Japanese rule. Mature state formation in both Koreas
21.	Vietnam		1428	Beginning of the Younger Le Dynasty	1883–1884	Final French conquest of Vietnam

#	State	Note	Approximate date of the phase beginning	Marking event	Approximate date of the phase end	Marking event
22.	France		1285	Beginning of the reign of Philippe IV the Fair	1665–1683	Colbert's reforms. Beginning of France's transformation into a mature state during the reign of Louis XIV
23.	Spain		1479	Unification of Castile and Aragon	1834–1843	The third revolution, formation of the constitutional monarchy regime. Beginning of Spain's transformation into a mature state
24.	Portugal		1385–1433	Reign of Juan I	1850s	Saldanha's liberal reform
25.	England		1485	Beginning of the Tudors' dynasty	1688	Glorious Revolution. Beginning of England's transformation into a mature state
26.	Sweden		1523–1560	Reign of Gustavus I Vasa	1771–1792	Reign and reforms of Gustavus III. Beginning of Sweden's transformation into a mature state
27.	Austria		1493–1519	Reign and reforms of Maximilian I	1780–1790	"Enlightened Absolutism" of Joseph II. Beginning of Austria's transformation into a mature state
28.	Russia		1547	Coronation of Ivan IV ("the Terrible")	1801	Beginning of the reign of Alexander I. Beginning of Russia's transformation into a mature state
29.	Poland		Late 15th – early 16th cent.	Formation of the *szlachta* "constitution" (the "Nobles' Commonwealth"	1795	The third division of Poland
30.	Denmark		1536	Royal reform in Denmark	1849	July 1849 Constitution. Denmark's transformation into a mature state
31.	USA		1776	Beginning of the Independence War	1829–1837	President Jackson's reforms. USA's transformation into a mature state
32.	Prussia		First half of the 17th cent.	Formation of the Brandenburg Prussian state	Late 18th cent.	Beginning of Prussia's transformation into a mature state

#	State	Note	Approximate date of the phase beginning	Marking event	Approximate date of the phase end	Marking event
33.	The Mughal State in India		1556	Beginning of Akbar's reign	1707	Aurangzeb's death. Beginning of the Mughal Empire's disintegration
34.	The Ottoman Empire		1520	Beginning of the reign of Suleiman I the Magnificent	1908	Revolution. Beginning of Turkey's transformation into a mature state
35.	The Netherlands		1579	The Utrecht Unity of the northern provinces of the Netherlands	1815–1839	Final delimitation of the Netherlands' borders; transformation into a mature state
36.	Iran		1587	Beginning of the reign of Abbas I	1925	Reza Shah being proclaimed the Shah of Iran. Beginning of Iran's transformation into a mature state
37.	Argentine		1826	Declaration of the Federal Republic of Argentine	1853	Adoption of the constitution of the Argentinean Confederation; beginning of transformation into a mature state
38.	Brazil		1822	Declaration of independence of the Brazilian Empire	1889	Declaration of the Brazilian Federative Republic; beginning of transformation into a mature state

During the whole of the 1st millennium CE the number of developed states and their analogues fluctuated significantly in connection with the rather well known complex and dramatic events of world history (the fall of the West Roman Empire, the Great Migration, Arab conquests etc.). However, in general their number remained rather small, whereas the territory under their control sometimes decreased significantly. The same can be observed with respect to the world urban population and urbanization rates. All this is rather congruent with those theories that maintain that the 1st millennium CE is a period of deep qualitative transformation of the World System and the whole historical process; the first millennium CE was a period of preparation for a new qualitative (and quantitative) breakthrough in the field of technologies and production as a whole (for more detail see Гринин 2003а, 2003б, 2006в).[14]

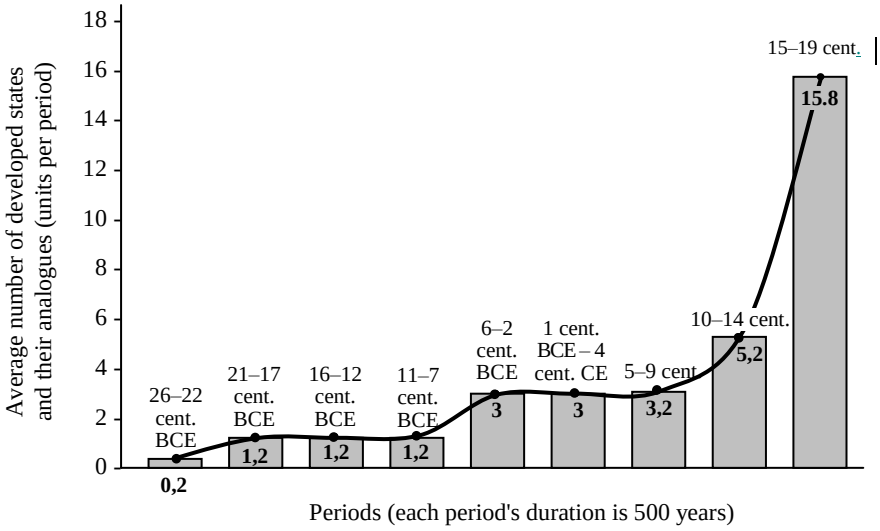
A new qualitative breakthrough (or what the first author refers to as "the transition to a new production principle") can be dated to the mid 15th century,

[14] We mean the so-called early industrial revolutions of the first half of the 2nd millennium CE; see, *e.g.*, Bernal 1965; Braudel 1973, 1982, 1985; Хилл 1947; Johnson 1955; Исламов, Фрейдзон 1986: 84; Гуревич 1969: 68; see also Дмитриев 1992: 140–141.

though some if its signs can be discerned in the 13th and 14th centuries (see Гринин 2003а, 2003б, 2006в for more details). Taking into consideration the expected time lag, this correlates rather well with a significant acceleration of the world urban population growth observed in the late 15th and 16th centuries. The same dynamics can be traced with respect to the number of developed states and the territory controlled by them (see the next article in the present Almanac).

The subsequent growth in urbanization (caused by the transition to industrial production) led not only to the "victory" of the developed states over the early ones, but also to the formation of a new evolutionary type of state: the mature state, which was tightly connected to industrialization and an industrial economy. The first such states developed in the late 17th century. Yet, already by the 19th century they had become dominant in Europe and the New World (see Table 2 and Diagram 1). Finally, by the end of the 20th century this type of state was prevalent everywhere, except possibly certain parts of Tropical Africa and Oceania.

Diagram 1. Growth of the Number of Developed States



Conceptual scheme of the characteristics of the early, developed, and mature states

Let us present now a conceptual comparative scheme of the characteristics of the early, developed, and mature states.

Early State

The early state is a *category, with which we denote* **a specific form of political organization of a sufficiently large and complex craft-agrarian society (or a group of such societies/territories) that controls its external policy and, partly, social order; at the same time this political form is a power organization separated from the population and which a) possesses sovereignty (or, at least, autonomy); b) is capable of forcing the population to fulfill its demands, change important relationships and introduce new ones, and redistribute resources; and e) is not built (basically, or mainly) on kinship principles.**

This definition does not mention professional administrative and control apparatus, regular taxation and artificial territorial division as necessary traits of the early state. The point is that in the early states those traits are almost never observed in their entirety. Thus, we maintain that these three traits are necessary characteristics for the subsequent evolutionary type of the state – the developed state.

The state as a form of political organization of the society reflects the social construction of the latter. Our analysis of the traits typical for the early state indicates that this state should be regarded as **incomplete**. *This incompleteness* implies that there are certain restrictions within the system of relationships between the state and society that block the further development of the early state. These restrictions mean that *such a relationship between the state and society is retrospectively (from the point of view of the evolutionary potential of the respective system) inadequate in comparison with what we observe within more developed systems.* Thus, it is in no way strange (what is more, it is perfectly normal) that most early states never evolved into developed states (see, *e.g.*, Claessen, van de Velde 1987a; 1991; Skalník 1996; Shifferd 1987; Tymowski 1987; Кочакова 1995), whereas those that did usually only achieved this through painful crises and cataclysms that caused a deep reconstruction of the entire system.

The restrictions manifest themselves in different ways. Sometimes the political form of the early state turned out not to be sufficiently tightly connected with the society. In such cases it did not "matter" (for a state superstructure) what it controlled. Take, for example, Central Asia where interstate borders did not get stabilized for centuries, they changed constantly in connection with purely military circumstances and the luck of a new conqueror (this is also rather typical for West Asia and North Africa). As another example, take Medieval Europe during the 11^{th} – 13^{th} centuries, where huge areas were transferred from one ruler to another, and from one polity to another as a result of rulers' marriages/divorces, deaths and inheritance cases.[15]

[15] Suffice to mention just one example. In the 12^{th} century the French King Louis VII obtained the largest (within France) Duchy of Aquitaine and the County of Poitou through a dynastic marriage to Eleanor of Aquitaine. However, he lost them rather soon as a result of his divorce with Eleanor. A

Europe at this time is an example of a political system with a weak administrative structure. However, we also find such cases of "incongruence" between the state and society when the political system of a state possesses a developed administrative apparatus that is able to control and regulate different territories. This could be observed in Mesopotamia where states frequently changed their borders, grew and shrank in a rather fast way, which was accompanied by a fast dynastic change. However, the principles of statehood remained the same as the bureaucracy easily imposed itself over any territorial configurations.

However, in some early states the above mentioned limitations expressed themselves in the fact that the links between the state and society were too tight, that is, some state form was appropriate only for a given society. As a result such states were incapable of performing qualitative transformations. A good example is provided here by the organization of the Greek *poleis*[16] that failed to transform themselves even when their independence was threatened. "A paradox of Greek history is that its main tendency was the continuous and generally unsuccessful aspiration to overcome the *polis*: it was continuous because of the incongruence of sometime established *polis* principles… with the subsequent social progress, whereas it was unsuccessful because the attempts to overcome the *polis* were undertaken on the very basis of the *polis*" (Фролов 1979: 6).

The first author of this article (Гринин 2001–2006; 2006а, 2006б, 2006г) has identified the two main types of incongruence between the political and structures of the ancient and medieval states.

The first and the most wide-spread incongruence is when the administrative structure of the state is underdeveloped. As was mentioned above, early states did not possess the complete set of important features of the developed state, or had not developed all (or some) of them up to a sufficient degree. In fact, some of these features could be rather developed, whereas the rest were underdeveloped (and some could just be absent). First of all, this is relevant for such statehood attributes as: (1) a professional administration/ control/oppression apparatus; (2) taxation; (3) artificial territorial division; and (4)

few months later she married Henry Plantagenet (Count of Anjou who also controlled within France the Duchy of Normandy, as well as the Counties of Touraine and Maine). Consequently, Aquitaine fell under Henry's control. The further development of events was even more interesting. Since the conquest of England by William, the Duke of Normandy, the kinship networks of the English and French nobility got intertwined very tightly, which led to Henry's becoming the King of England. Consequently, all the above mentioned French territories (stretching from the English Channel to the Pyrenees and exceeding the size of the royal domain of the King of France) fell under the control of the King of England (who still remained formally a vassal of the King of France) (see, *e.g.*, Кириллова 1980: 216–217; Колесницкий 1980: 194; Люблинская 1972: 97).

[16] Note that the second author of this article avoids denoting most of the classical Greek *poleis* (including Athens) as "states" (see, *e.g.*, Korotayev *et al.* 2000).

the presence of written law and written administrative documentation (orders, directives, reports, archives, *etc.*)[17].

This is easier to understand if we recollect that in some early states we find natural rather than artificial territorial divisions, or such divisions as based on clans, tribes, or local communities (see, *e.g.*, Korotayev 1995, 1996)[18], in some early states we find tribute, gifts, temporary loans rather than true regular taxation, etc. Frequently taxes were irregular; for example, often they were only collected during wars. In some cases they could be absent all together, as the government could have other sources of revenue, such as monopolies on some types of trade (including foreign trade), or some types of economic activities (*e.g.*, extraction of salt and other minerals), special lands and territories whose revenues were used to support the ruler (thus, in medieval Europe revenues of the royal domain were frequently the main source of the state finance); tribute and contributions paid by subjugated areas; compulsory payments of allies (as, for example, within the Athenian *arche*) and so on. In the early Roman Republic a very important source of public financing consisted of revenues from the public lands that were rented out, whereas taxes were only collected in extraordinary circumstances (see, *e.g.*, Петрушевский 2003 [1917]: 86).[19] It was not always the case (especially in the Ancient period) that early states had regular armies, whereas rulers relied on levies as their main military force. Also, police systems were seldom found in these Early states.[20]

Frequently early states had a rather weak apparatus of administration and oppression. Sometimes this weakness was combined with a primitive character of social stratification, as, for example, could be observed in the European "barbarian kingdoms" of the early Middle Ages. On the other hand, estate-class stratification could be expressed in a rather distinct way, whereas the administrative apparatus was weak and non-bureaucratic, as could be found in Athens, Rome and other states (or state analogues) were professional administrators were either absent all together (and magistrates occupied their positions in turn or by drawing lots), or they did not receive salaries and were elected for short periods of time (see, *e.g.*, Osborne 1985: 9; Finley 1977: 75; Штаерман 1989).

Such incomplete early states were often just imposed over societies and restricted themselves to military and redistribution tasks, collection of tribute and duties without penetrating deeply into social life. Ancient Russia was such a

[17] It is not infrequent when the social stratification in the early states is not sufficiently pronounced (see, *e.g.*, Маретина 1987; see also Куббель 1973: 232; Томановская 1973: 280).

[18] Many examples of this can be found in Tropical Africa (see, *e.g.*, Куббель 1988: 132, *etc.*).

[19] A rather telling statement is made by Trouwborst (1987: 136) who notes that the states of the African Great Lakes region did not create a full-fledged taxation system and adds that if they had created it, this could have been the *end* of the early state.

[20] It is not surprising that with respect to the early states the data on the presence of police forces are extremely scarce. For example, among two dozen early states surveyed by Claessen (Claessen 1978: 560) he only managed to find some evidence of the presence of police systems in four cases.

state for a rather long period of time as well as many states created by nomads, many early states of Tropical Africa and so on. It was not rare when a young state nourished a vigorous layer of new nobility that stopped taking into account the interests of the very state that had created it and began to shape social processes for on their own. A clear example is provided here by the titled nobility of medieval Europe that transformed service fiefs into private property, enslaved peasants, stripped the kings of their tax-payers and soldiers, and finally transformed kingdoms into nominal entities. Similar processes could be observed during certain periods in histories of many other countries starting from rather ancient epochs (for example in China of the Chou period: Васильев 1993: 187–189; see also Крюков 1974: 14–15; Крил 2001).

The process described above is representative of the *typical* early state phase and turned out to be a period of feudal decentralization. That is why the following statement makes sense: "Political decentralization of the early feudal epoch is not a symptom of the state's weakness, but a natural condition (within the observed circumstances): this was a hierarchicized alliance of vassals and seniors based on a system of personal links that were the prevalent form of social relations in this society" (Гуревич 1970: 60).

In small (and to some extent in medium-size) states the administrative apparatus was usually underdeveloped and insufficiently separated from the population due to their sizes. Indeed, within such a scale many problems can be solved in a rather effective way by means that are different from state orders and controls (they could be solved, for example, by private persons, through the direct expression of the population's will, or through the activities of clans, professional organizations and social groups). Here the growth of statehood was connected first of all with the necessity to wage successful wars, and sometimes to organize foreign trade. An important role could be played by the state in the settlement of social conflicts, as this was observed in Athens, some other Greek *poleis*, and to some extent in early Rome (with respect to the conflict between plebeians and patricians). As a result of such conditions, some features of statehood were strengthened and others lagged behind. The particulars depended on the peculiarities of concrete polities. Spartan, Athenian, Phoenician (as well as Roman and Carthaginian [naturally until the respective polities remained small]) ways are just some versions of such development.

On the other hand, large early states of the imperial type that originated as a result of conquests were bound to disintegrate or to get radically reduced in size. Empires rarely remained powerful for more than 100 consecutive years (see, *e.g.*, Taagapera 1968, 1978a, 1978b, 1979). Numerous rises and falls of Assyria in the 13^{th} – 7^{th} centuries can serve here as a clear example of this (see, *e.g.*, Садаев 1979). However, even when an early state was sufficiently militarily strong to keep its provinces under its control for long periods of time, it usually still turned out to be insufficiently developed to integrate effectively its constituent parts. There was usually a pronounced imbalance between the statehood of the center and its periphery (see, *e.g.*, Thapar 1981: 411). The second author of this article maintains that a typical early empire was a *multi-*

polity, that is, a political system consisting of a state in its center and various non-state polities at its periphery (see, *e.g.*, Korotayev *et al*. 2000: 23–24). And such states as republics of Rome[21], or Carthage were not tightly integrated systems, but rather conglomerates of territorial polities. They possessed systems of special links between the center and every people, every region, every territory, whereas some peoples/communities had more rights, some others had fewer rights, some were almost equal to the center, and some had an extremely low status.

The second kind of incompleteness of the early state was opposite to the first and by far less frequent. We are referring to those states that possessed a developed bureaucratic administrative apparatus while, at the same time, possessing an underdeveloped social structure. Such states lacked sufficiently distinct forms of social stratification (that is, they did not have clearly expressed classes or estates, and lacked sufficiently mature land property relations). What is more, an overdeveloped administrative apparatus could block the formation of a sufficiently developed and stable social system.

Examples of the above situation are: Egypt of the Ancient Kingdom; the Inca Empire; Sumer of the Third Dynasty of Ur (the 21st century BCE, when, in Vitkin's words [Виткин 1968: 434], the state acquired an antisocial form); and the subsequent state of Hammurabi[22]. Thus, it may be said that, in such states, bureaucracy (notwithstanding all its organizational importance) was an external superstructure over society. In other early states, military nobility with its retinues was imposed over society. However, these elites possessed different methods for exploiting and influencing the society (see Гринин 2006б for more detail).

In the first case weak governments sometimes failed to sufficiently mobilize a country's resources as they dealt with self-willed nobility and local governors; in the second case, the state suppressed the society by trying to restructure it entirely to meet the needs of the state. It took upon itself the functions of resource redistribution and production organizer/controller. Such a state hypertrophy developed within the conditions of a subsistence economy (as was observed, for example, in the Inca Empire). However, an obsession with registration and control could also be found in societies with commodity-market relations if state duties in kind were also prevalent there; for example, the collection, transportation, storage, and redistribution of duties kind are much more arduous and cumbersome than the accumulation of money.

However, overdevelopment of the bureaucratic administrative apparatus within the state of the Third Dynasty of Ur and the kingdom of Hammurabi sharply distinguished them from the rest of the archaic states. Hence, though,

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[21] Note that the second author considers Roman *civitas* as a state alternatives (Korotayev *et al.* 2000).

[22] See on the Inca Empire: Березкин 1991; Зубрицкий 1966; 1975; Инка Гарсиласо 1974; Кузьмищев 1974; Mason 1961; Schaedel 1978; on Ancient Egypt: Перепёлкин 1988; 2001; Виноградов 2000; Заблоцка 1989; Брестед, Тураев 2003; Жак 1992; on Mesopotamia: Дьяконов 1983: 370; Заблоцка 1989; Козырева 2000: 83; Оппенхейм 1990: 66, 67.

on the one hand, these states could be considered early states, on the other, they could also be regarded as developed state analogues (we have taken this into account both in Table 1, and when calculating the territory under the control of developed states and their analogues).

Developed state

First of all, it is necessary to note that the developed state is more organic for society; to be more exact, the state becomes its natural political form, though the fitting process could proceed painfully and turbulently. The road to the developed state was lengthy and complicated as the developed state was a result of numerous transformations, upheavals, splits and reintegrations; within these processes there was a natural selection leading to more effective types of interaction between the state and social/ethnic structures. Significant progress in state political, administrative and legal arrangements as well as ideology was needed so that the developed state could appear. On the other hand, a certain level of ethnic, social, economic, and cultural development was necessary as a result of which society becomes sufficiently consolidated socially and ethnically. It is rather essential that the developed state is not only tightly connected with the society's social and corporative structure and formalizes them in political institutions, but that it also influences them much more purposefully and actively.

The developed state is centralized and complete, that is, it has all of the state attributes. Such a state is formed as a result of a long period of development of administration techniques, expansion and professionalization of administrative structures, and the coordination of the state agencies to perform their various designated tasks. Thus, many features (professional administration/oppression apparatus, regular taxation, artificial territorial division, written law) that could be absent in the early states, are necessarily present in the developed states.

Hence, **the developed state is** *a category that denotes* **a natural form of political organization of a civilized society (or a group of such societies) that is characterized by a centralized organization of power, administration, coercion and order maintenance in the form of a system of special institutions, positions (titles), organs, laws (norms) and that possesses (a) sovereignty; (b) supremacy, legitimacy and reality of power within a certain territory and a certain circle of people; (c) and has the capability to change relations and norms.**

We have also formulated the *minimum* characteristics of the developed state that distinguish it from the early state.

a) The developed state has more statehood attributes, and these attributes are more elaborated. The developed state has all the statehood features in a rather clear and systematic form: a special professional administration/coercion apparatus separated from the population; regular taxation; and an artificial territorial division. It also always has a written law and a special cul-

ture of written documentation, registration, and control.[23] Such a state cannot rely on levies and has a regular professional standing army. It has a more developed taxation system. Archaic duties and revenues (tribute, gifts, labor-rents, revenues from state-sponsored plundering and contributions) disappear, or play subordinate roles. Taxation becomes more regular and ordered.

b) The developed state is an estate-corporative state. The social structure of the developed state becomes represented by large social groups, and not by numerous tiny social layers or socio-territorial units (like autonomous cities or temples with special privileges) as it is for early states. Large ethnic groups develop in place of conglomerates of tribes and small peoples. As a result, society becomes sufficiently consolidated socially. The estate consolidation is connected with a decline in the isolation of areas and territories, with economic unification of the society, and with more intensive contacts within the elites representing different parts of a country. With respect to states one cannot help but notice that the activities of a developed state are directed toward the legal shaping of estates, at making the society more stable, at ordering social mobility. On the other hand, both the state structure and its policies reflect the peculiarities of its social (and ethnic) composition; the state actively influences the social structure of society and acts as an intermediary between various estates/corporations. We can frequently observe a process of more distinct shaping of the system of titles and officials' ranks (in the latter case it is especially relevant when the ruling class is identical with the officials' corporation (what is denoted as "state-class" by Cheshkov [Чешков 1967: 243–245]).

c) The developed state is always a centralized state; generally, it is much more durable and stable than the early state. The developed state cannot be a political conglomerate, as was frequently the case with respect to early states. This is not just a set of territories that disintegrate as soon as the central power weakens. Of course, the disintegration can be experienced by the developed states rather regularly (especially, during the transition from primitive to typical developed statehood[24]). However, if the further development of such a state occurs it is always connected with a new and tighter form of centralization within more or less the same territory. This is accounted for by the fact that the state is formed within a definite, historically prepared (both materially and culturally) territory with a common culture, ideology, writing, and with the development of communications, trade, a certain unification of money types, measures, law, and so on. Hence, the higher the level of statehood devel-

[23] Note that it was not infrequent when in the early states (even when the writing was available) not all the state acts were written. Many (and sometimes most) acts remained oral. For example, according to Jacques Le Goff (Лe Гофф 1992: 45), this was the case in the empire of Charlemagne.

[24] They were also regularly observed at the end of political-demographic cycles. It should be noted that pre-industrial socio-demographic cycles usually ended with a political-demographic collapse, after which a new cycle normally began (see, *e.g.*, Turchin 2003; Nefedov 2004; Turchin and Korotayev 2006; Korotayev, Malkov, and Khaltourina 2006b).

opment, the more stable it is with respect to the destabilizing influence of various crises (including the socio-demographic crises), and the faster is its transition to the recovery growth phase (see, *e.g.*, Korotayev, Malkov, and Khaltourina 2006)[25].

d) The developed state is characterized by a more developed economic base. In particular, unlike the early state, the developed state cannot form without cereal production (let alone the fact that it cannot develop on the basis of animal husbandry), whereas some early states (first of all in Tropical Africa) were formed on the basis of such agriculture domesticates as yams, bananas, manioc, peanuts etc. (see, *e.g.*, Бондаренко 1995: 103). The developed state cannot fail to possess an internal market, it cannot be based on subsistence economy, unlike some early states (*e.g.*, the Inca Empire, or Egypt of the Early Kingdom period). At least some development of market relations is necessary. There should be not only some craft specialization, but also some regional specialization, that is an integrated economic organism should start its formation within the state.[26]

e) Many early states existed in the form of barbarian societies, whereas **the developed state can only be based on a civilized society.** That is why such states only develop in the areas of rather advanced civilizations (and frequently on the basis of leading ethnic groups).

f) The developed state conforms significantly better than the early state to the definition of the state as **an organization of coercion functioning in order to keep the lower classes under the domination of the higher classes and to secure the exploitation of the former by the latter**. The social role of the state changes. The developed state, being an estate-corporative state with a stable social order, performs its role of an organizer of coercion much more effectively than the early state; this coercion serves the interests of upper strata (classes) in a more effective way, which makes it possible for them to exploit the lower strata and to keep them under a tight control, [27]whereas in many early

[25] However, the transition to the mature statehood (or the transition from a primitive mature state to a typical mature one) was quite frequently connected with profound social upheavals, social and political revolutions, as this was observed in England, France, Russia and other countries, whereas sometimes such crises resulted in temporary state breakdowns, as this happened, for example, in China in the first half of the 20th century.

[26] On the formation of such a market, for example, in Russia, China, Japan, and England see respectively Преображенский 1967: 25–28; Хромов 1988: 148–152; Симоновская, Лапина 1987: 119; Гальперин 1958: 27; Кузнецов и др. 1988: 115; Винокуров 1993: 48; Лавровский, Барг 1958: 72.

[27] In fact, Claessen and Skalnìk emphasized this point when they noted that the mature state becomes an instrument in the hands of the social class of the owners of land and other means of production (Claessen and Skalnìk 1978a: 634). However, this emphasis on the private ownership of the means of production replicates the mistake of vulgar Marxism that insisted on the presence of economic classes in all the complex agrarian societies, whereas in most of them the private ownership of land played a subordinate role that was not so important in comparison with a person's position within the state hierarchy.

states exploitation was not very pronounced (see, *e.g.*, Trouwborst 1987: 131; Service 1975). As the state itself takes the functions of maintaining social order, it reduces the possibilities of the upper strata to solve the problems of coercive support of their position by themselves; for example, through the prohibition for them to have their own armed forces, to build castles and fortresses, to apply certain coercive measures to those dependant on them (which increases the importance of law-courts and state administration. This (in addition to other factors) contributes to the more pronounced role of the state coercion with respect to various social groups in the developed state, as compared with the early one.

g) The presence of a new type of state ideology and/or religion. Political ideology in the wide sense of this term develops in place of primitive ideas of royal power (based on notions of mythical ancestors, royal supernatural capabilities and so on). A telling example is provided here by the Confucianism in China (Васильев 1983; Лапина 1982). However, such an ideology usually had certain religious forms, like the 16th century Russian treatment of Moscow as "the Third Rome" (see Пайпс 1993: 306–307). As a result, in many developed states (as was observed in China and other East Asian countries according to Martynov [Мартынов 1982: 6–7]) the state became sacred by itself. In areas with church-type organization of major confessions this demanded an alliance between the state and the official church (with respect to some European states see, *e.g.*, Ле Руа Ладюри 2004: 8).

It is quite natural that different states entered the developed state phase in different ages. Hence, it makes sense to outline a chronology of concrete states entering this phase (a more comprehensive [but less detailed] chronology can be found in Table 1). However, the indicated dates refer to the beginning of the transition into developed statehood, with the main transformations taking place later, sometimes much later[28]. For example, the Roman state reached this level by the late 1st century BC, with the formation of the emperor's power. However, it is only by the late 3rd century that the Roman Empire distinctively demonstrates all the features of the developed state. In this case those distinctive features are manifested in a "hierarchical system of estates, hereditary ascription of people to their professions and statuses, a huge elaborated police-bureaucratic apparatus, 'theocratic' power of the Emperor, the state religion that was obligatory for all the subjects and that sanctioned the official ideology" (Штаерман 1968: 659; see also Петрушевский 2003).

In a few cases it appears possible to speak about the beginning of the initial phase of the developed state only retrospectively, taking into consideration the

[28] In Table 1 for the sake of formalization we had to connect such transformation to certain dates, which, of course, oversimplifies the situation, as it is quite clear that such serious transformation could not take place within a single year (however important it was), but usually occurred in the span of decades. In addition to this, some of the dates are disputed; yet we did not find it appropriate to discuss various hypotheses on concrete dates within the present context.

further evolution of the respective state. Such changes are described by Lukonin (Луконин 1987: 141, 137) with respect to Iran in the following way: "The early Sassanid monarchy in its essence was not very much different from the Parthian one, however, the changing circumstances helped to gradually centralize the state. The *polis* is replaced with the 'royal city', the system of semi-independent kingdoms is replaced with the unified state administrative system, the religious tolerance of the Parthian kings and multiplicity of religions are replaced with the unified state religion – Zoroastrianism....The Sassanid period is characterized by a constantly growing tendency towards centralization".

Egypt entered the developed state phase at the beginning of the New Kingdom Age in the 16th century BCE. In this period we observe major changes in the Egyptian economy as it becomes more intensive and productive, among other things through the use of a new type of plough, hydraulic devices, and the execution of large-scale irrigation projects. There is a considerable progress in crafts, proliferation of bronze tools, development of private property and trade (Виноградов 2000a: 370–372; Перепелкин 2001: 259–280). In fact, it was just at this time when the evidence on market transactions and commodity exchange appeared and become numerous, when silver began to supplant grain in the function of money, though incompletely (see, *e.g.*, Монтэ 1989: 167–168). Considerable changes also took place in socio-political life (Виноградов 2000a: 370–372; Перепелкин 2001: 259–280). Centralization increased and the monarch's autonomy decreased radically. A large military empire was created, which was accompanied by the formation of new layers of state administrators (in particular, military and civil administrators of a new type) and a redistribution of material resources in their favor. The working population became freer compared to the "king's servants" of the Middle Kingdom Age, though many things regarding agrarian relations during this period remain unclear, including information about what rights peasants had with respect to the land they tilled and how they were connected to the land itself (Стучевский 1982: 118; 1966). Within the New Kingdom we see quite a clear formation of corporate structure and a higher separation (including the hereditary character of the occupations) of various social strata: priests, warriors, craftsmen of different specializations, which became even more pronounced in subsequent epochs. This brought the structure of Egyptian society closer to the structure of estate societies and, as we have mentioned, the presence of large all-state estates is a very important feature of the developed states.

China reached this stage as a result of its first unification in the late 3rd century BCE under Qin Shi Huang[29]. Changes that had taken place in the country

[29] However, in a few Chinese states of the Zhango period (especially within the Qin state itself [that became the unification core]), as a result of the legist reforms (with respect to Qin these are the Shang Yang reforms of the 350s BCE), we can observe a sort of transition to polities that can be already regarded as developed state analogues (see Table 1). Note that we have taken this point into account below when we calculated the sizes of the territory under the control of the developed states and their analogues.

were enormous, as Qin Shi Huang's reforms had changed the administrative system and territorial division of the country. These reforms unified legislation, the writing system, and the system of measures and weights; the money system was reformed, the Great Wall was completed, and so on. These reforms also led to enormous social transformations (Крюков, Переломов и др. 1983: 17–21; Переломов 1962).

Byzantium was a developed state from the very beginning, because the Roman tradition was not interrupted there. Thus, it is not strange that in comparison with contemporary Barbarian kingdoms, Byzantium stood apart from the point of view of its regular and unified legislation and legal systems. According to some estimates, by the 6th century the population of the Byzantine empire reached 50–65 million (Удальцова 1988: 34, 15).

By the 3rd century CE, Iran can already be regarded as a developed state with the consolidation of the Sassanid dynasty. Already since the reign of the first Sassanid king, Ardashir I (227–241), major transformations took place in this country (they were caused both by purposeful governmental actions and spontaneous social processes); these transformations included the abolishment of the vassal kings and their replacement with governors, the strengthening of centralization, adoption of a new religion, formation of new estates, reform of the territorial division, change of ethnic characteristics of the population, linguistic and cultural consolidation of the country (Луконин 1987; Новосельцев 1995: 24, 31; see also Фрай 1972; Колесников 1987). Note for example, that the Shahinshah appointed the heads of the four estates, which comprised the nation, at the level of the whole state (Колесников 1987: 185)

It may be suggested that Japan entered the developed state phase by the early 15th century, when *Shōgun*s of the Ashikaga dynasty managed to strengthen their control over centralized power and, as a result, they came close to being in the position of absolute rulers of the country, though the period of their real power was not long (Толстогоузов 1995: 561; Кузнецов и др. 1988: 89)[30]. Centralization attempts were undertaken in Japan already since the 12th century, which among other things manifested themselves in the formation of the very institution of shogunate (1192 CE). However, it was only in the 15th century when one could detect contours of the socio-political system that reached its maturity two centuries later, during the Tokugawa shogunate: a deified Emperor who does not actually rule; concentration of real power by the *Shōgun*; his reliance on the military servant estate of the *samurai*; concentration of regional power by the local rulers (*daimyō*) who, however, were controlled by the *Shōgun* in a variety of ways. Naturally, the overall system was based on resources extracted from the tax-paying estates of peasants, craftsmen, and merchants. The *samurai* estate was already formed, to a sufficient degree by the

[30] As this happened frequently at the first phase of the developed statehood, the political centralization declined some time later, and the internal warfare started. The second phase of centralization was over by the late 16th century.

14th century when it was finally separated from the peasantry, whereas the *daimyō* estate began its formation just in the 15th century (Кузнецов и др. 1988: 73, 89; Спеваковский 1981: 12–17).

France entered this phase in the late 13th century during the reign of Philip IV the Fair (1285–1314)[31]. By this time in France, due to the activities of his predecessors and favorable economic development, we observe the formation of a sufficiently developed administrative apparatus, a taxation system, court system, and the general strengthening of the state. The royal domain had significantly grown, though the level of political centralization was still rather low. We can also observe the formation of estates and their political representation (*les états généraux*) (Люблинская 1972: 94–109; Цатурова 2002: 12–13; Hay 1975: 138). However, the Hundred Years' War retarded the process of the French statehood development. Afterwards, since the first half of the 15th century, they had to restart the political centralization process from an extremely low benchmark, when the main issue was the very survival of France and her French king (Hay 1975: 153–160).

Spain entered this phase in the late 15th century (as a result of the union of Castile and Aragon). The joint reign of Ferdinand and Isabella (1479–1504) was a turning point in Spanish history. They managed to unite the country, to strengthen the order within it, to undertake important reforms, to establish an effective control over nobility, though its strength had not been eliminated till the end (Johnson 1955: 105–106). The discovery and colonization of the New World accelerated the development of Spain.

England entered this phase in the late 15th century and the early 16th century (after the end of the War of the Roses and the Tudor dynasty coming to power). It was already Henry VII (1485–1509) who achieved much with respect to the political centralization of the country; in general, as a result of the Tudor dynasty reign that lasted more than a century, a new political system (absolute monarchy) formed and flourished in England (see Дмитриева 1993: 163), though English absolutism was significantly different from it French (let alone Russian) counterpart (см. Сапрыкин 1991: 207–208; Карев 1993: 160–161).

For many European countries the 16th century was a "period of state construction" (Elliott 1974: 80). But this century also served as a turning point for the political evolution of such countries as Russia, India and Iran. In Russia the developed state formed in the second half of the 16th century during the reign of Ivan the Terrible (1547–1584). Changes in political and social life of Russia that took place in this period are well known. Ivan revised the law code (known as *Sudebnik*), created a standing army (the *streltsy*). He reformed the central and regional administration by establishing the *Zemsky Sobor* (a legislative body of parliamentary type), the council of the nobles (known as the Chosen

[31] He became famous because of his confiscation of the huge assets of the Knights Templar (*Pauperes commilitones Christi Templique Solomonici*), and the movement of the official seat of papacy to Avignon.

Council), the local self-government in rural regions. Then he annexed the Kazan and Astrakhan Khanates (see, *e.g.*, Шмидт 1999).

In India the developed state formed some time after the creation of the Mughal Empire, in the second half of the 16th century, during Akbar's reign. In contrast to its predecessor, the Delhi Sultanate (the 13th and 14th centuries) a number of whose achievements were applied within the Mughal state, the latter was a much stronger and more centralized empire[32]. Akbar who ruled for half a century (1556–1605), united under his rule the main part of the Indian territory and conducted important reforms of state administration that in many respects continued the line of Akbar's grandfather, Babur (Азимджанова 1977:152). However, the further development of Indian statehood met with considerable difficulty, though in some respects (in particular with respect to the elaboration of the administrative system) it reached a considerable degree of maturity (see, *e.g.*, Ашрафян 1987: 230). India remained at the level of a primitive developed state, and, as a result of the long and cruel reign of Akbar's grandson, Aurangzeb, (1658–1707), the Mughal Empire began to decline and virtually self-destructed (Антонова 1979: 213–225, 233–241).

An inability for further development also manifested itself in Iran. After centuries of foreign rule, crises and stagnation, in the late 16th century and the early 17th century, during the reign of Abbas I (1587–1629) and his successors Iran became again a large and powerful state. Important reforms were conducted. At this time we can say that Iran entered again the developed state phase. However, subsequent rulers turned out to be not sufficiently able, and in the late 17th century and the early 18th century, economic situation in the country became critical, trade (including the foreign trade) declined, the tax burden increased, social relations between the populace and state became aggravated, and rebellions began. A political and economic crisis developed, which was aggravated by Turkish and Afghan invasions, as well as interference by foreign powers; these resulted in the extreme devastation of the country and economic stagnation. Even a temporary strengthening of Iran during the reign of Nadir-Shah who became famous due to his successful wars, including the capture of Delhi in 1739, did not change the situation for long. At the end of his life Nadir-Shah himself conducted such an irrational internal policy that after his death the country experienced political disintegration, internal wars, power struggle between various cliques. Iran virtually disintegrated again (Петрушевский 1977; Кузнецова 1986: 229). And as in the 18th and 19th centuries the country

[32] The Delhi Sultanate "was a weakly centralized feudal state" (Ашрафян 1960: 74). It achieved the peak of its might during the reign of Alauddin Khilji (1296–1316). However, his huge empire was an unstable military-administrative formation, from which a considerable number of principalities split by the end of Alauddin's rule (Ашрафян 1960: 228). The Mughal Dynasty was founded by the famous Central Asian warrior and poet Babur (from Timur's lineage) who started his conquest campaigns in India in 1519. He conducted a number of important reforms (especially, with respect to taxation) in the conquered part of India (see Азимджанова 1977).

was under the strong influence of Russia and the European powers, its further independent development was greatly hindered.

The entrance of the Ottoman Empire into the developed state phase can also be dated to the 16th century. It appears that this transition took place during the reign of Suleiman I Kanuni (the Lawgiver) who was called the Magnificent by the Europeans (1520–1566).[33] By this time we can observe the formation of a sufficiently effective military fief system that provided the Empire with a rather battle-worthy and large army. The Ottomans developed a system of registration of fief-holders (the *sipahi*s). Suleiman elaborated it by forbidding the governors to distribute the fiefs and to confirm the rights of the fief heirs. He also conducted a number of important reforms with respect to administrative division, taxation ordering, relations between landlords and tenants. Numerous laws on the administration of various provinces (that regulated administrative organization, taxation, property relations and so on) were worked out. The level of administrative organization also was rather high by the contemporary standards (see, *e.g.*, Findley 1989).

During this time Turkey can be considered to be a sufficiently centralized empire, whose backbone was represented by the military fief (*timar*) system (see, *e.g.*, Орешкова 1986), whereas its center was one of the largest world cities of the century, Istanbul, whose population in 1550 is estimated to have been between 400 and 500 thousand (Петросян 1990: 72–73, 103).[34]

Turkey was the only Eastern empire that managed for a rather long time (and not always without success) to compete militarily with some European powers and even their alliances.

Mature state

We believe that the mature state (as we define it) is a result of the development of capitalism and the Industrial Revolution; thus, it has a radically different production basis than previous state types. In addition to this, the transition to the mature statehood (or its analogue) is connected with the demographic revolution. Depending on concrete circumstances it could take place during different phases of the development of the mature state (that is, during its first or

[33] However, it cannot be excluded that the formation of the developed state may be dated to the end of the reign of Bayezid II (1481–1512), or the beginning of the reign of Selim I (1512–1520). Already during the reign of Bayezid II the Ottoman socio-political and economic institutions were put in order, a rather clear religious-legal was developed for them, which was connected with activities of a large group of the Ottoman *`ulamā'*. In general, during the reigns of Selim I and Suleiman I Ottoman state institutions acquired that developed form, which afterwards was considered as a classical standard (Иванов, Орешкова 2000: 76).

[34] Note that if the tradition maintaining that Selim I took the Caliphal title from the last Egyptian Abbasid Caliph after the Ottoman conquest of Egypt still had some substance (though it is generally regarded now as the late 18th century fabrication [see, *e.g.*, Sourdel *et al.* 1990]), this could be regarded as a rather logical measure, as it would have strengthened the power of the Ottoman sultans providing additional legitimization for their power over their subjects most of whom were Muslims (Петросян 1990: 58–69, 72).

second phase, or even during the final phase of the developed statehood). Yet, in almost all the industrialized countries a very rapid, explosive population growth was observed (see, *e.g.*, Armengaud 1976; Korotayev, Malkov, Khaltourina 2006a; with respect to Russia see: Водарский 1973; Нефедов 2005)[35].

Table 2. Estimated Populations of Various European Countries from 1800 to 1910 (in millions) (Armengaud 1976: 29)

	1800	*1850*	*1900*	*1910*
Denmark	0.9	1.6	2.6	2.9
Finland	1.0	1.6	2.7	3.1
Norway	0.9	1.5[36]	2.2	2.4
Sweden	2.3	3.5	5.1	5.5
Belgium	3.0	4.3[37]	6.7	7.4
Holland	2.2	3.1	5.1	5.9
Great Britain	10.9	20.9	36.9	40.8
Ireland	5.0	6.6	4.5	4.4[38]
France	26.9	36.5	40.7	41.5
Spain	11.5	15.5[39]	18.6	19.9
Portugal	3.1	4.2[40]	5.4	6.0
Italy	18.1	23.9	33.9	36.2
Switzerland	1.8	2.4	3.3	3.8
Germany	24.5	31.7	50.6	58.5
Austria-Hungary	23.3	31.3	47.0	51.3
Bulgaria	–	–	3.7	4.3
Russia[41]	~56	~76	133.1	156.4

[35] As is well known, this was the result of the first phase of the demographic transition. The point is that during the first phase of this demographic transition a rather sharp decline in mortality rates is observed. Indeed, when technology starts growing significantly faster than the population (as in the 19th century Europe), this results in a significant growth of GDP per capita, and hence, per capita consumption, improved health care, sanitation, water supply, population health status, growth of life expectancies, and hence the decrease of mortality rates. This is followed by a decline in fertility rates (through the introduction of family planning practices and technologies as a proximate cause), but with a substantial time lag. As a result, for considerable periods of time we observe pronounced trends in the rise of the population growth rates against the background of growing population. This, of course, produces just a hyperbolic effect – the higher the population, the higher the population growth rate. Since the 19th century more and more populations of the world entered the demographic transition. Till the 1960s the number of populations which entered the 2nd phase of the demographic transition did not compensate for the hyperbolic growth of the 1st phase populations; hence, the hyperbolic growth trend was characteristic not only for individual populations, but also for world population as a whole (for more detail see, *e.g.*, Korotayev, Malkov, and Khaltourina 2006a: 92–104).

[36] In 1855.

[37] In 1845.

[38] Note, however, that in order to have a more sound picture of the overall Irish population dynamics one should take into account such facts as that, according to the 2000 census, the total number of the Irish living in the United States exceeded 30.5 million (U.S. Census Bureau 2006).

[39] In 1857.

[40] In 1867.

It might not be coincidental that Malthus' *Essay on the Principle of Population* was published in 1798 (that is, just during the British Industrial Revolution).

The mature state significantly surpasses the developed stare with respect to the complexity and efficiency of its political organization and legal system; it necessarily has a professional bureaucracy, distinct mechanisms and elaborated procedures of legitimate power transition. We usually observe the working out of constitutions and the division of powers, and the role of law (especially civil law) significantly increases. In general (with the exception of totalitarian and authoritarian states), in mature states the systems of law and court procedures reach such a level of development and elaboration that it appears difficult to compare them with the ones of earlier epochs. As a result one of the most important functions of the mature state is to secure not only the social order, but also the legal order, which was often paid little attention by the developed states.

Thus**, the mature state can be defined as** *a category that denotes* **an organic form of political organization of an economically and culturally developed society, a system of bureaucratic and other specialized political institutions, organs and laws supporting the internal and external political life; it is an organization of power, administration, and order maintenance that is separated from the population and that possesses: a) sovereignty; b) supremacy, legitimacy and the reality of power within a certain territory and a certain circle of people; c) a developed apparatus of coercion and control; d) the ability to change social relations and norms in a systematic way.**

It makes sense to pay attention to the point that the developed state is defined as a *natural* form of the political organization of society (that is, though the developed state is necessary to sustain social order in a supercomplex agrarian society, in principle, its main agricultural population could do without a state, let alone a large state if there were no threat of external invasions). In contrast, the mature state is defined as an *organic* form of the political organization of a society, that is, such a form without which a respective type of society (and its population) could not reproduce itself in principle.

In the meantime, statehood itself becomes virtually separated from the concrete persons. In the monarchies of the initial period of the mature states a monarch (like Louis XIV) could still claim: " *L'État, c'est moi*!"[42] (note, however, that this was the 17th, not 20th, century), whereas in the constitutional regimes this became just impossible. We could also observe the development of certain autonomy of the bureaucratic apparatus and army that more and more

[41] As Armengaud's population data with respect to Russia do not appear reliable, we have chosen to reproduce Shelestov's (Шелестов 1987: 156, 166) estimates for this country – L.G., A.K.

[42] Or such claims could be meaningfully attributed to him by his opponents.

act as an abstract mechanism of civil service[43]. All these serve as a basis for the formation of civil society.

With respect to the relations between the state and society – that is, the state and the person – we find it necessary to speak about the formation of a new type of ideology that can be denoted as **civil** ideology, because it explained the relations between the person and the state from the point of view of the person-citizen who had equal legal rights and duties and lived in a nation-state. As a result of revolutions, reforms and proliferation of education this civil ideology gradually replaced the sacred traditional ideology of the developed state that implied the sanctity of the monarch's power and the inviolability of the estate social order. **Nationalism** can be considered as the most universal type of civil ideology. Liberalism, democratism, revolutionism, and reformism can be regarded as other influential ideologies of the age of classical capitalism. The later period observed the formation of imperialism (as an ideology), communism, fascism, and anticommunism. As a result, the very criteria of the state's dignity changed. The splendor of the Court was replaced with the economic power of the nation, a more just social order, and, subsequently, the quality of the life of the population as criteria for judging the level of state development.

In the mature state, administration institutions, as well as the apparatus of coercion and control, are both more elaborated and more specialized than in the developed state; while in the latter those organs and institutions did not always have clearly demarcated functions. In the developed state both supreme and local administrative organs were often multifunctional and indefinite with respect to their tasks.[44] Real bureaucracy was only concentrated primarily within certain spheres that were different in different countries (for example, in taxation, or courts of law), whereas it could be absent in the other spheres of life, especially at the level of local government.[45] And such a situation did not always change immediately at the level of the primitive mature state (cf., for example, the situation in France in the 18th century [Малов 1994: 140]), whereas this is only changed in really systematic way at the level of the typical mature state.

France can be regarded as a mature state since the late 17th century (the reign of Louis XIV). Let us mention just one telling example: by the early 16th

[43] Even in totalitarian countries their rigid ideologies, "popular" ruling parties, and other institutions existed formally "for the well-being of the people and society", which restricted significantly the opportunities of the officials' personal self-enrichment.

[44] For example, in the 16th century in France (as well as in Russia and other countries) we find the "narrow" council of the king whose composition was indefinite and whose functions were rather vague. The same can be said about the representatives of the contemporary administration – *bailliages, sénéchaussées, prévôts, gouverneurs* with "their extremely indefinite administrative-judicial and military-administrative jurisdiction" (Сказкин 1972: 170, 171). "Outside the court and government the classical monarchy is characterized by a partial, and sometimes weakly centralized system of administration". The situation only began to change in the 17th century, especially under Richelieu (Ле Руа Ладюри 2004: 15).

[45] Even in pre-Modern China the bureaucratic apparatus did not penetrate the local level where the administrative functions were performed by the "literati" (see, *e.g.*, Никифоров 1977: 211–213).

century there were 8 thousand officials in France, whereas by the mid 17th century their number grew to 46 thousand (Копосов 1993: 180).

In England the mature statehood formed in the first decades of the 18th century, that is, some time after the Glorious Revolution when a new system of state government started to develop: constitutional monarchy, two-party system, one-party government.

In Prussia the mature statehood had existed since the late 18th century. By the early 19th century "within military, as well as civil, administration it established standards for whole Europe" (Парсонс 1997: 100). In Russia it has existed since the early 19th century--since the reforms of Alexander I and Speransky. In Japan it appeared in the last third of the 19th century (after the "Restoration of Meidji"). The USA became a mature state after the period that is denoted as "Jackson's Democracy" after the name of President Andrew Jackson (1829–1837) when we observe the formation of the two-party system and the abolition of the electoral qualification system.[46]

China can be regarded as a mature state analogue since the late 17th century or the early 18th century (the final period of Kangxi's [1661–1722] reign). This state managed to organize politically an enormous (even from the present-day point of view) population against the background of its very fast (for the 18th century) demographic growth (McNeill 1993: 240–244). During the 18th century the Chinese population grew from 100–150 to over 300 million (Крюков и др. 1987: 61–63; Korotayev, Malkov, and Khaltourina 2006b: 47–88; McNeill 1993: 240). In Qing China we can also observe a rather high level of administrative technologies, a number of social innovations atypical for developed (but not mature) states (for more detail see Гринин 2006а, 2006 в).

The main characteristics of the mature state:

a) it is already an industrial or industrialized state in which a unified economic organism integrated by effective communications is formed. The ensuring of its normal functioning becomes a more and more important task of the state. An important role is also played here by military needs;

b) it has a sufficiently high level of administrative organization, a developed system of laws, or state regulations (as was found in the states of the "Communist Block");

c) it is based on a nation (or a set of nations), that is why it can only exist within a society with a unified national (or supranational) culture (for more detail on the tight relations between the nation and the state see Armstrong 1982; Gellner 1983; Фрейдзон 1999: 10–12; Гринин 1997б; 2003а: 201–203, 222–235). That is why such a state is concerned with its influence on culture, including control over language, religion, education and so on. Hence, the mature

[46] Naturally, in the *initial (primitive)* phase of the mature statehood we find some archaic features that are inherited from the earlier epochs, a certain weakness of the state. For example, in France in the 18th century the sale of governmental posts continued, the internal customs remained, whereas in Russia the serfdom survived till 1861. Later such archaisms disappear as a result of evolutionary and revolutionary transformations.

state ideology always includes some nationalism (or some other ideas on the superiority of the given state's population; for example, their special progressiveness, revolutionary spirit, love for democracy/freedom, special historical deeds, *etc*.);

d) in connection with the growth of the role of property relations, the establishment of legal equality of the citizens, the abolishment of estate privileges the mature state is gradually transformed from the estate-class state to the purely **class-corporate** state, in which the main role gradually begins to be played by industrial classes (the role of estates gradually dwindles to zero, whereas the role of property relations and one's place within the state/party system increases). As the class division is mostly economic (see, *e.g.*, Weber 1971; Вебер 2003), and not juridical, it becomes necessary to have organizations and corporations that express the interests of certain parts and groups of certain classes (and sometimes interests of a certain class as a whole). These are various organizations and political parties of both workers (see, *e.g.*, Bergier 1976) and bourgeoisie, as well as other social strata;[47]

e) in the developed states mass literacy was almost never observed, written information sources were controlled by the elites, whereas the mass literacy is normal for mature states were written information sources became available to the general population already in the 18th and 19th centuries and where the importance of mass media grew enormously. This stimulated radical changes in the forms, styles and directions of administration and contacts between the government and the people;

f) finally, the mature state bases itself on new types of infrasocietal links:

– material links – unified economic organism and unified market;

– cultural links – unified culture-information organism;

– national links – consciousness of national unity and development of new symbols of this unity: nation, national interests, supreme interests;

– consolidation on the basis of ideology: cult of law and constitution, cult of nation (or cult of party, idea, leader);

– consolidation on the basis of participation in pan-national organizations and corporations (trade unions, parties, movements) and participation in pan-national elections.

[47] For example, in Britain the first national federation of the entrepreneurs' unions appeared in 1873; in Germany 77 various entrepreneurs' organizations were created in the 1870s, whereas in the 1890s 325 new organizations of this type appeared (Григорьева 2001: 25) It is necessary to take into account the fact that within the context of a developed class stratification even purely economic corporations cannot remain politically neutral. In particular, the trade union movement with its growth and strengthening "inevitably tries to influence the state and its economic and social policies" (Шлеппнер 1959: 386).

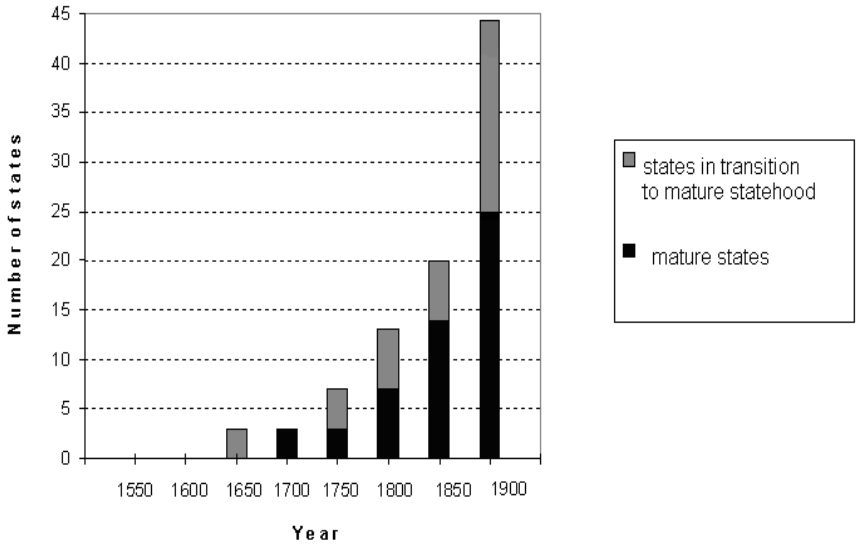
Table 2. Chronological Table of the Mature States' Formation

Year	*Mature states and their analogues*	*States in the phase of transition to the mature statehood*
1500	0	0
1600	0	0
1650	0	3 (France, Britain, China)
1700	3 (France, Britain, China[48])	0
1750	3 (France, Britain, China[49])	4 (Austria, Prussia, Russia, Sweden)
1800	7 (France, Britain, Austria, China[50], Russia, Prussia, Sweden)	6 (Denmark, Italy[51], Spain, Portugal, the USA, the Netherlands)
1850	14 (France, Britain, Austria, China[52], Russia, Prussia, Sweden, Belgium, Denmark, Spain, the USA, Piedmont [Italy], Switzerland[53], the Netherlands)	6 (Argentine, Brazil, Mexico, Portugal, Chile, Japan)
1900	25 (France, Britain, Austria, Argentine, China, Russia, Prussia, Sweden, Belgium, Brazil, Denmark, Spain, the USA, Italy, Switzerland, the Netherlands, Bulgaria, Germany, Greece, Italy, Mexico, Portugal, Serbia, Chile, Japan)	19 (Australia, Vietnam, Egypt, India, Iran, Ireland, Canada, Korea, Cuba, New Zealand, Norway, Poland, Rumania, the South African Union, Turkey, Uruguay, Finland, Philippines, Iceland)

The overall dynamics of the number of mature states are presented in Diagram 2:

[48] A mature state analogue according to the first author of this article.
[49] A mature state analogue according to the first author of this article.
[50] A mature state analogue according to the first author of this article.
[51] It may be maintained that with the Napoleonic conquests in Italy and the formation of a united Italian state (first a republic, and then a kingdom – under the French protectorate) Italy began to move rather fast towards mature statehood. We believe that the transition of a number of Italian states (Venice, Florence, Genoa) to developed statehood had already taken place in the 15th century, but because of constant wars, invasions, internal influences, instability of interstate boarders and states themselves the political development of Italy slowed down in subsequent centuries.
[52] A mature state analogue according to the first author of this article.
[53] According to the second author of this article, before the 1840s the political system of Switzerland represented an alternative form to the developed state, whereas it was transformed directly into the mature state in the 1840s, as a result of the suppression of the *Sonderbund* rebellion.

Diagram 2. Dynamics of the Mature States' Number (1500–1900 CE)



Mature state transformation in the 20th century

The mature state phase is connected with the formation of classes of entrepreneurs and workers, and the **development of the class-corporate state**. For the mature European states this process was completed approximately by the late 19th century. The first author of this article has already expressed the idea that the fuller the legal equality of human rights, the weaker the borders between social classes that tend to get disintegrated into smaller and less consolidated groups: strata, factions, *etc*. (for more detail see Гринин 1997a: 61–62). This occurred in Europe in the first half of the 20th century. Such a transformation of the mature state is connected with very fast changes in production and related spheres, including acceleration of migration processes, creation of conveyor production, explosive growth of the education subsystem, the service spheres, women's employment, and so on (on some of these processes see, *e.g.*, Маршалл 2005: 23). Suffice to mention that the world industrial production grew between 1890 and 1913 four times (Соловьев, Евзеров 2001: 280).

The most important features of the new social structure are as follows:

– formation of the so called middle class that gradually became numerically dominant (Фишер 1999: 89);

– growth of the importance of such factors of social stratification as education, and an increase in social mobility (Фишер 1999: 91). Consequently, the proportion of "white collar" workers grew in the most significant way;
– growth of the importance of social legislation and the laws limiting social polarization (such as the ones introducing high income taxation, inheritance taxation and so on)[54];
– growth of the importance of such factors that were not significant before on the national/pan-state level (though they could have been rather important at the level of smaller social units): gender, age, and professional group characteristics.

During the 20th century social policy experienced radical changes. We can observe **the transformation of the class state into the *social* state, that is the state that actively pursues a policy to provide support for poor, socially unprotected groups and that places limits on the growth of inequality.** This process started in the late 19th century, it became visible after the First World War, and it produced salient results after the Second World War[55]. Actually, the whole of the first half of the 20th century can be characterized as a period of struggle for the introduction of the most important social laws. The respective views and ideologies were changed dramatically by the global social and economic events: revolutions, the example of the USSR, the world economic crisis and so on. Later this course was strengthened and developed until Western European and other developed countries became "welfare states" (on this dynamics of social development see Фишер 1999: 335–351). Immense changes took place in the sphere of income redistribution. This was achieved, in particular, through the progressive income taxation (see, *e.g.*, Фишер 1999: 86–87) and social welfare programs for low-income groups. As a result of the development of social programs the taxation rates grew significantly in comparison with the period of classical capitalism (reaching 50% and more of personal incomes)[56].

When in the 1950s and 1960s the USA and a number of European countries became **welfare states/mass consumption societies**, this implied that the mature state had acquired some features that were not typical of its earlier version, and that a new form of state had developed.

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[54] In the last decades of the 20th century in some developed countries the lower class shrank to 5%, the upper class constituted less than 5% of the total population, whereas the rest of the strata could be attributed to the middle or lower-middle classes (see Фишер 1999: 89), whereas in the early 19th century up to two thirds of the total population belonged to the lower class (*ibidem*).

[55] In some cases the first laws of this kind were already passed in the 19th century. In particular, in Germany the first social insurance laws were passed under Bismarck (Григорьева 2001: 23, Патрушев 2001: 76; Гренвилл 1999: 17). In Britain the first social insurance (in particular, pensions) laws were already begun to be passed in the early 20th century (see Пономарев 2003: 171).

[56] They only began to be reduced since the 1980s in connection with the introduction of the neoconservatist course (that corrected the previously dominant Keynesian one) into the economic policies of a number of the leading states, such as the USA, Britain and so on. In particular, in the USA in 1986 the upper limit of personal income taxation was reduced from 50 до 28%, whereas the maximum rate of taxes on the corporations' profits was reduced from 46 to 34 % (Повалихина 2002: 434).

In the 1960s new changes in all spheres of life (especially in connection with the new [information-scientific] production revolution) began. In particular, one could mention the growth of the role of various non-class social movements in the Western countries (student, youth, race, "green", women movements, consumers' organizations and so on). The class characteristics became more and more vague, among other things through the dispersion of ownership (see, *e.g.*, Dahrendorf 1976), whereas the social structure became determined more and more not only by economic ownership, but by other parameters, including education and popularity.[57] We believe that all these features cannot be regarded as characteristic of the mature state; the same can be said about enormous social guaranties provided to the commoner population.

There are a number of interesting features that are not characteristic of the typical mature states. The most salient among them is a perfectly new and very important phenomenon – a partial renunciation by many states of their sovereignty as regards the determination of their internal taxation, customs, coercive and social policy, their right to wage wars and so on, due to their voluntary joining of regional and global organizations, the recognition of the priority of international law over national law (for more detail see Гринин 1999; 2004a; 2005). It is also necessary to note the formation of various supranational organizations and the growth of their importance.

Thus, many present-day characteristics of the Western states cannot be regarded unconditionally as the ones of the mature state. Hence, since the 1960s and 1970s the United States and the leading European states (Germany, France, states of Northern and Northwestern Europe) could be regarded as *transitional* mature states, within which some traits of the future supranational, suprastate political forms emerge (for Japan and some European countries not mentioned above this is relevant since the 1980s and 1990s). This implies that they have some features that are not characteristic of the state as a form of political organization. That is why there are certain grounds to expect that the end of the period of the mature states is forthcoming, and the world is entering a phase of its new (suprastate and supranational) political organization (for more detail see Гринин 1999; 2003a: 159–165; 204–206; 234–235).

In this respect the simultaneity of the change in the basic features of the mature states and the radical changes in the world demographic dynamics observed in the recent decades (see, *e.g.*, Korotayev, Malkov, and Khaltourina 2006a) do not appear coincidental.

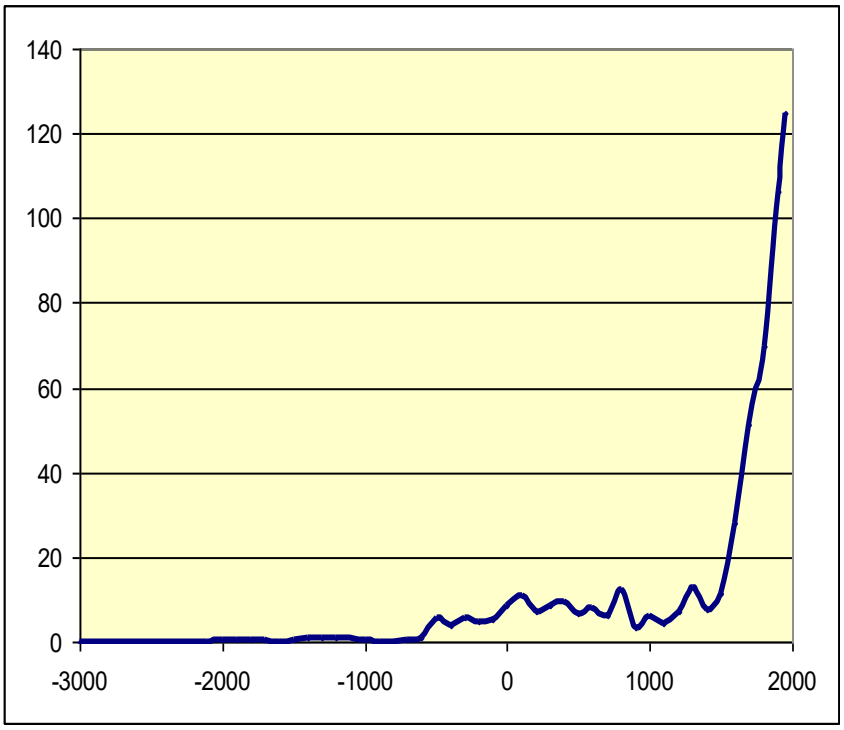
Finally, let us analyze the dynamics of the territory controlled by developed and mature states and their analogues.

[57] See, *e.g.*, Парсонс 1997: 27; Бергер 1994. The works of the first author of this article provide an analysis of the contemporary social processes, in particular those connected with the so-called "celebrities" (Гринин 1997a: 50; 2003a: 220–222; 2004б; 2004в).

A preliminary mathematical analysis of the dynamics of the territory controlled by developed and mature states and their analogues

A general picture of this dynamics up to 1950 can be presented as follows (see Diagram 3):

Diagram 3. Dynamics of Territory Controlled by the Developed and Mature States and Their Analogues (millions km^2), till 1950

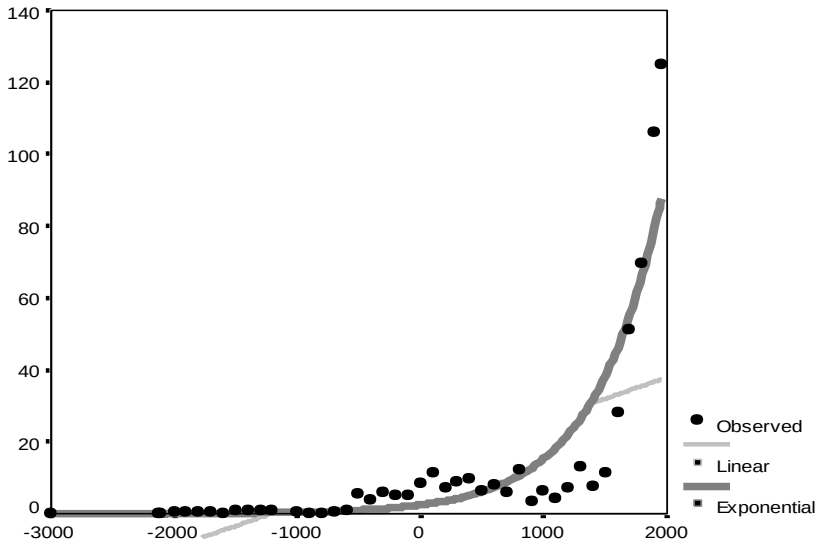


NOTE. The dynamics of territory controlled by developed and mature states (and their analogues) have been determined on the basis of Tables 1 and 2 above in conjunction with Taagapera's database (Taagapera 1968, 1978a, 1978b, 1979, 1997), the *Open History* database[58] (http://www.openhistory.net), as well as the *Atlas of World History* (O'Brien 1999).

These dynamics are described rather well ($R = 0.835$, $R^2 = 0.697$, $p < 0.001$) by an exponential model (see Diagram 4):

[58] This database has been developed by us with financial support of the Russian Foundation for Basic Research (Project # 06–06–80459a).

Diagram 4. Dynamics of Territory Controlled by the Developed and Mature States and Their Analogues (millions km^2), till 1950: correlation between predictions of linear and exponential models and empirical estimates



NOTES. Black markers correspond to empirical estimates. *Linear regression*: $R = 0.566$, $R^2 = 0.343$, $p < 0.001$. The thin light grey best-fit line has been generated by the following equation: $X_t = 14.3038 + 0.0118t$. The best-fit parameters here and elsewhere have been determined with the least squares method. *Exponential regression*: $R = 0.835$, $R^2 = 0.697$, $p < 0.001$. The thick dark grey best-fit curve has been generated by the following equation: $X_t = 2.4422 \times e^{0,0018t}$. In order to make the exponential regression possible we ascribed to the period preceding the formation of developed states (and their analogues) the value of 0.0001.

At first glance, a high correlation between the empirical estimates of the variable under consideration and the exponential model does not appear to be coincidental. Indeed, one may suppose the presence of a positive feedback between the territory controlled by the developed states and the rate of the developed statehood territorial expansion (the larger the territory controlled by the developed state, the more resources it will have at its disposal; hence, the higher the territorial expansion rate[59]). This statement can be expressed mathematically in the following way:

[59] This is, for example, the logics of the exponential model of the world political centralization dynamics suggested by Taagapera (1968, 1978a, 1978b, 1979, 1997). In addition to this, one should take into account the factor of cultural influence, the borrowing of the developed states' technolo-

$$\frac{dX}{dt} = kX \ , \tag{1}$$

where X is the territory controlled by the developed states. As is well known, such differential equations have a solution of the following form:

$$X_t = a \times e^{\,bt}. \tag{2}$$

However, one may suppose that expansion rates of developed statehood (naturally, if a vast periphery not yet controlled by the developed statehood is available) depend not only on the size of controlled territory, but also on the level of the development of statehood itself, that is on the level of the development of political technologies (T):

$$\frac{dX}{dt} = aTX \ . \tag{3}$$

On the other hand, in order to describe mathematically the dynamics of political technology development one may apply Kremer's general equation[60] describing technological dynamics:

$$\frac{dT}{dt} = bNT \ . \tag{4}$$

Let us recollect that in this equation N denotes the total number of people – potential innovators – within the respective system. With respect to the equation describing the political technology development dynamics N should be interpreted as the number of potential agents of political technology innovations, *i.e.*, the professional administrators. Further assume that the number of agents of the state apparatus is proportional to the territory controlled by the state organization (the larger the territory, the higher the number of state agents necessary to administer it). Hence,

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gies in religious, political, military, production and other spheres, as well as modernization processes that both facilitate the developed/mature states' expansion and accelerate the early states' transformation into developed states (as was observed, for example in East and South-East Asia, or Europe in the 2nd millennium CE. It should also be taken into account that military activities conducted by developed/mature states against other polities can contribute to the expansion of the developed state type. This is so not just in case of the developed states' victories, but in the case of a prolonged struggle the necessity to counteract a developed state could lead to the start of the modernization of a country that lacks developed statehood, whereas in case of a developed state's victory some elements of developed statehood tend to be borrowed by the defeated state. However, the time lag between the fall of developed states and the rise of new ones could be rather long, which is clearly evidenced by the 1st millennium record.

[60] The justification for this equation can be found in the following publications: Kremer 1993; Podlazov 2004; Tsirel 2004; Korotayev, Malkov, and Khaltourina 2006a, 2006b.

$$N = cX \ . \tag{5}$$

By inserting equation (5) into equation (4), we obtain

$$\frac{dT}{dt} = k_1 XT \ , \tag{6}$$

where $k_1 = cb$.

Thus, we arrive at the following system of equations:

$$\frac{dX}{dt} = aTX \ , \tag{3}$$

$$\frac{dT}{dt} = k_1 XT \ . \tag{6}$$

Hence,

$$\frac{dT}{dt} = \frac{k_1}{a}(aXT) = \frac{k_1}{a}(aTX) = \frac{k_1}{a}\frac{dX}{dt} \ ,$$

consequently,

$$\frac{dT}{dt} = k_2 \frac{dX}{dt} \ , \tag{7}$$

where $k_2 = \frac{k_1}{a}$.

Hence, T can be expressed through X in the following way:

$$T = T_0 + k_2 X \ . \tag{8}$$

Inserting equation (8) into equation (3), we obtain

$$\frac{dX}{dt} = aTX = a(T_0 + k_2 X)X = aT_0 X + ak_2 X^2 ,$$

and, taking into consideration that $k_2 = \frac{k_1}{a}$,

$$ak_2 X^2 = a\frac{k_1}{a}X^2 = k_1 X^2 ;$$

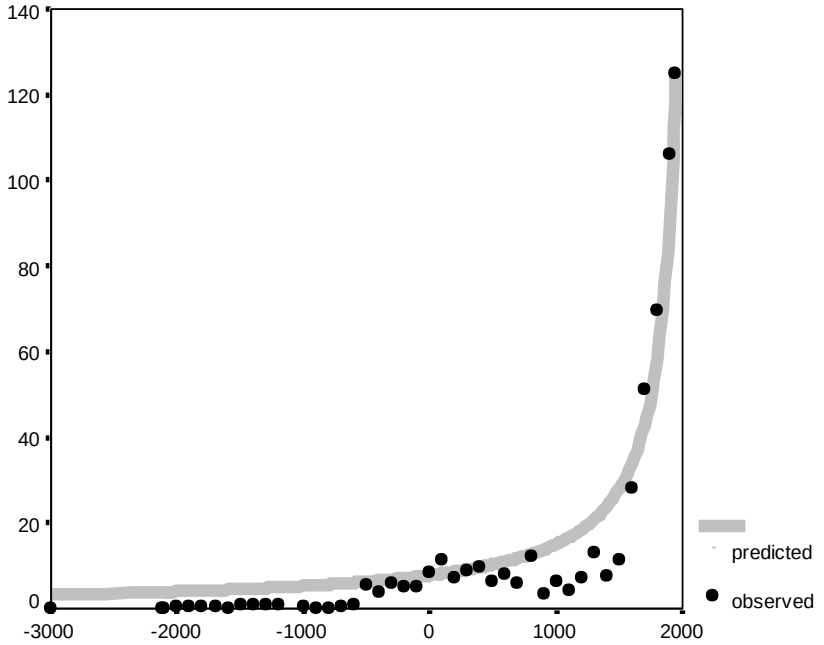
hence,

$$\frac{dX}{dt} = aT_0X + k_1X^2. \quad (9)$$

Thus, if the assumptions above are correct, the general dynamics of the size of the territory controlled by the developed and mature states and their analogues should be not exponential, but rather hyperexponential, and should be better described by a hyperbolic rather than exponential model.

Indeed, the hyperbolic model demonstrates a much better fit with the empirical estimates (see Diagram 5):

Diagram 5. Dynamics of the Size of Territory Controlled by Developed and Mature States and Their Analogues (in millions of square kilometers), till 1950 CE: the fit between predictions of simple hyperbolic model and empirical estimates



NOTES: $R = 0.979$, $R^2 = 0.958$, $p << 0.0001$. Black markers correspond to empirical estimates. The solid grey curve has been generated by the following equation:

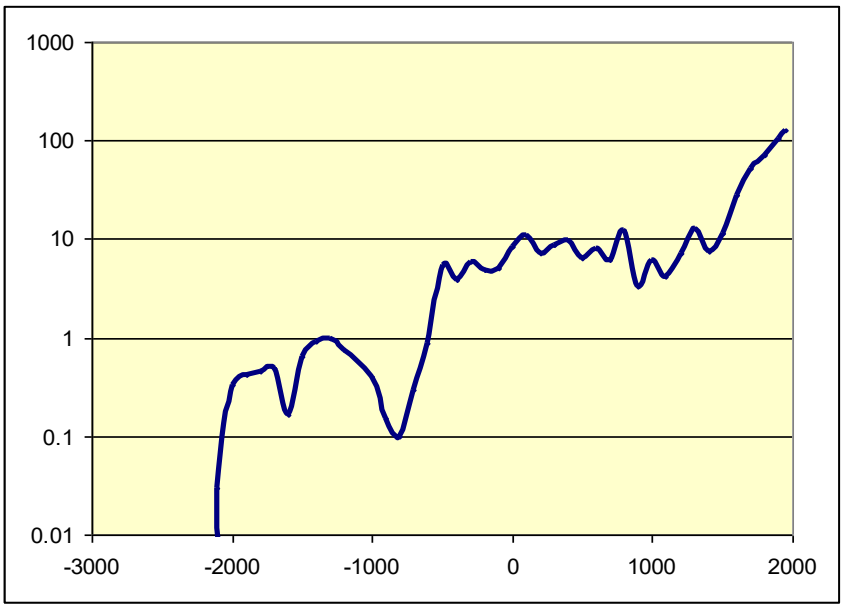
$$X_t = \frac{16260}{(2080 - t)^2}.$$

Parameters C (16260) and t_0 (2080) have been calculated with the least squares method.

We would like to emphasize that this model only describes the general trend of the variable's dynamics, whereas a more accurate mathematical description of these dynamics should also take into account the evident cyclical component, which, however, is beyond the scope of this article.

To start a preliminary analysis of the fine structure of these dynamics (that will be continued in the next article of this Almanac) it makes sense to consider these dynamics in logarithmic scale (see Diagram 6):

Diagram 6. Dynamics of the Size of Territory Controlled by Developed and Mature States and Their Analogues (in millions of square kilometers), till 1950 CE **(logarithmic scale)**



As we can see, this diagram detects essentially the same system of attractors and phase transitions that was found in the previous article with respect to the world urbanization dynamics. A more detailed study of the relationship between the dynamics of the two variables will be performed in the next article of this Almanac.

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The Urbanization and Political Development of the World System: A comparative quantitative analysis[1]

Andrey Korotayev and Leonid Grinin

Because the relationship between urbanization and the evolution of statehood is a rather voluminous subject, we shall only consider a few aspects of this relationship[2]. First of all, it appears necessary to note that the very formation of the state is connected with urbanization directly, or indirectly[3]. Among factors that contribute to both state formation and urbanization the following, appear to have been especially important: a) population growth (see, *e.g.*, Claessen and van de Velde 1985; Chase-Dunn and Hall 1994; Fried 1967a, 1967b; Service 1975; Korotayev, Malkov, and Khaltourina 2006a, 2006b; Гринин 2006a); b) development of trade (Ekholm 1977; Webb 1975)[4]; and c) growth of wealth[5].

It also appears necessary to note that the "urban" way of the early state formation was one of the most important ones (for more detail see Гринин 2006a). Urbanization was connected with the concentration of people as a result of the compulsory merger of a few settlements due, usually, to pressure from a military threat. Such a situation was typical for many regions: for Ancient Greece (Глускина 1983: 36; see also Фролов 1986: 44; Андреев 1979: 20–21), Mesopotamia, in particular in the late 4th millennium and the 3rd millennium BCE (Дьяконов 1983: 110, 2000a, 1: 46), a number of African regions; for

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[2] This issue has been also considered in some previous publications by the second author of this article (see, *e.g.*, Гринин 1999, 2006a; see also Grinin 2006).

[3] The factors of state formation are very numerous (for more detail see Гринин 2006a) and their analysis goes beyond the scope of this article.

[4] The role of transit and external trade in the development of many early states was very important. Many of them, like medieval Ghana, were (to use Kubbel's expression) "huge foreign trade superstructures" (Куббель 1990: 72). The state monopolization of the trade sources, exotic imports, and trade duties was a very important accumulation source within such states, according to Chase-Dunn and Hall (1997: 236).

[5] For example, Diakonoff maintains that in the late 4th millennium BCE "the Sumerians began to get fabulous (by the standards of that time) yields from their fields. The well-being of the communities grew fast; the concentration of the population of each canal area around its cult center grew simultaneously. Thus, the settlement pattern changed sharply – it seems that it was safer for the people to keep together: wealth appeared, it could be robbed, and it made sense to defend it". As a result, the resettlement of inhabitants of small villages to the area around the wall of a central temple became a characteristic process of this period (Дьяконов 1983: 110).

example, in South-East Madagascar in the 17th century a few small states of the Betsileo originated in this way (Kottak 1980; Claessen 2000, 2004). In Greece this process was called *synoikismos*.

Population concentration contributed in a rather significant way both to the urbanization and state formation process and development[6]. In particular, the density of contacts within a polity is a very important factor of state formation (Гринин 2001–2006; 2006a). And, as this density is higher in urban than rural societies, the politogenetic processes within them have certain peculiarities in comparison with those societies that lack cities.

Thus, state formation is connected rather tightly with city formation even though the correlation between the presence of the state and the presence of the cities is still far from 100%, though it is quite high as some scholars, for example, Adams (1966) believed. Adams, in fact, considered the presence of cities a necessary characteristic of the state. Of course, this relationship is not coincidental as economic, social, and many political processes (including the ones involving the institution of the state itself) of the state are intertwined with urbanization processes; to some extent they are based on it. On the other hand, the state influences urbanization processes. The state is a complex integrative institution that concentrates the development of many relationships within itself. Similarly, the city also implies a complex concentration consisting of geographical, social, political, and sacral, resources and assets. "The city is a direct territorial concentration of a multiplicity of heterogeneous forms of human activities" (Ахиезер 1995: 23).

Hence, most factors of politogenesis and state formation are connected with urbanization. The development of religion and the rulers' sacralization is inevitably connected with the development of temple systems, temple cities, or cities that acted as centers of religious life. The immense role of the military in the formation of the state is very well known (Ambrosino 1995; Carneiro 1970, 1978; Southall 2000), and it is not coincidental that fortress cities were a predominant type of cities in the period in question. On the other hand, military devastation was one of the most important causes for the destruction and death of cities and the decline of a city's population. The formation of an elite played a pivotal role in these processes, but the elites tended to concentrate just in cities. It is also quite clear that the processes of social stratification and class formation proceeded in many ancient agricultural societies under a considerable influence of the "urban revolution" (Алекшин 1986: 22).

The state is impossible without centralized power (see, *e.g.*, Claessen 1978: 586–588; Claessen and Oosten 1996: 2; Claessen and van de Velde 1987: 16; Ember and Ember 1999: 158, 380; Fortes and Evans-Pritchard 1987/1940; Haas 2001: 235; Spencer 2000: 157, *etc*.; see also Гринин 2001–2006; Grinin 2003,

[6] The population concentration leads to the spatial structurization of settlements, to which so much attention is paid by modern archaeologists (see, *e.g.*, Адамс 1986). And the higher the demographic density, the more pronounced the structurization (including the spatial structurization) (Гиренко 1991: 91).

2004). Hence, we believe that the relationship between urbanization and the evolution of statehood is especially transparent with respect to the formation and development (as well as the influence on social life) of the central settlement of the state (that is, its capital [see below for more detail]). Most frequently centralized power is geographically materialized as the main settlement of a country, its capital (though there were some exceptions like the empire of Charlemagne that lacked a real capital city [Дэвис 2005: 221]). The role of centralized power is especially significant in large developed states. It is difficult to overestimate the role of such gigantic urban centers as Rome, Constantinople/Istanbul, Moscow and so on in the life of their respective empires; and it is important to note that the population concentration of these cities was exceptionally high.

It is also necessary to note that the vector of the state's activities largely determines the process of urbanization: its intensity and direction, as well as the concrete transformations of concrete cities. By "concrete transformation" we mean the construction of fortresses, the destruction of cities during wars, the creation of cities as base stations or trade factories in conquered territories (as was done, for example, by Alexander the Great), as well as with colonization activities (as was typical for the Phoenicians, Greeks, Genoese, *etc.*). Sometimes the destruction of and enemies' cities and deportation of their population fed the growth of the victors' capitals, as this happened, for example, in the 14th century with Samarkand (to where craftsmen from conquered cities were deported by Timur *en mass*).

In a number of early and developed states, political changes were connected with the transfer of the capital from one city to another, or the construction of a new capital. For example, in Japan in 639 CE the capital was transferred by Emperor Jomei (Пасков 1987: 34); Sargon the Great made a previously unimportant town Akkad his capital (Дьяконов 2000б: 57). Andrew the Pious established his capital in the Vladimir-Suzdal Principality in a new town, Vladimir-na-Klyazme (Рыбаков 1966: 617). One can easily recollect cases when capitals were erected "at a blank space", as happened, for example, during the formation of the Golden Horde. As an example from the history of the developed states one may mention the transfer by the pharaoh-reformer Akhenaten of the Egyptian capital to the newly-built Akhetaten ("Horizon of Aten") named after the newly introduced single deity Aten (see, *e.g.*, Trigger 2001: 78; Виноградов 2000a: 377–382). Another famous example is the erection of the new Russian capital Saint Petersburg by Peter the Great .

The processes of the growth and development of capitals (as well as the urbanization as a whole) could be also affected by such political factors as the struggle against separatism and other activities aimed at strengthening centralized power. For example, for these purposes the center tried to attract the nobility to the capital, and sometimes their representatives (or children) were kept in the capital as honorable hostages to insure the loyalty of their parents and relatives; some ancient Chinese states of the Zhou period (Johnson and Earle 2000:

294; Pokora 1978: 203) or Benin (Бондаренко 2001: 222–223) could be mentioned here as examples. However, such phenomena could be found not only among early states, but also among developed ones. For example, Qin Shi Huangdi, the founder of the first centralized Chinese empire, deported 120 thousand families of hereditary aristocracy, high-ranked officials and rich merchants to his capital Xianyang during the first year of the country's unification, 221 BCE (Переломов 1962: 154). In the 17th – 19th centuries the *Shōgun* government of Japan had to look constantly after the activities of the *daimyo* (the local rulers) and to keep them as hostages in the capital (Гальперин 1958; Топеха 1958; Губер и др. 1982; Сабуро 1972: 142; Сырицын 1987: 149–151; Кузнецов и др. 1988: 110–112). On the other hand, in Ottoman Egypt, the *mamluk bey*s and other member of the top echelon of the Egyptian elite were "virtual hostages of the capital", as they were afraid to leave Cairo for long because of the constant intrigues and acute competition among the *mamluk* houses (Kimche 1968: 457). In addition, their obligatory participation in the *divan*s (governmental councils) demanded their presence in the capital. In Russia Peter the Great in order to develop the new capital demanded from the top echelon of the elite to build houses in Saint Petersburg and to spend their considerable periods of time.

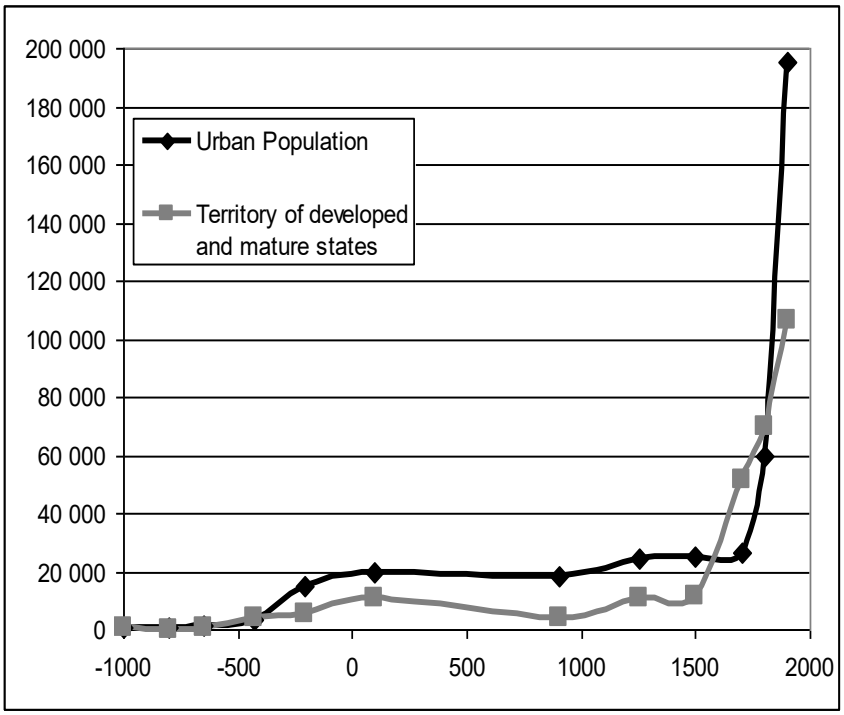
On the other hand, the development of cities is a necessary condition for the formation and growth of developed states (for more detail see Гринин 2006а; 2006в). In particular, the developed statehood implies some regional economic specialization, that is, the beginning of the formation of a unified economic organism in the respective country. For example, the formation of the "all-Russian market" began in the second half of the 17th century (Преображенский 1967: 25–28; Хромов 1988: 148–152), whereas in China "the economic specialization of individual cities, areas and regions had become clear by the 16th century" (Симоновская, Лапина 1987: 119). In Japan in the 17th century we find some definite specialization of regions, in particular with respect to some industrial crops – indigo, cotton, flax, sugar-cane and so on – which tended to be cultivated in particular regions (Гальперин 1958: 27). There was also some regional division of labor with respect to industrial products: various textiles, metal and lacquer products, paper, ceramics, porcelain, and so on. Osaka hosted not only the central market of the country, but also a rice exchange center which bought rice from local and regional farmers and gave credits against security of future crops (Кузнецов и др. 1988: 115). In Britain the unified national market had already formed by the 16th century and it developed actively throughout the whole of this century (Винокуров 1993: 48; Лавровский, Барг 1958: 72). Naturally, such specialization influenced the dynamics of urban development.

Industrialization is a necessary condition for mature state development. Naturally, industrialization is intrinsically connected with vigorous urbanization processes including, among other things, the development of cities with more than one million inhabitants and internal migrations to cities from the countryside

(see, *e.g.*, Бессонов 1999; Дмитриевская 1999). In addition to this, mature statehood is intrinsically connected with nationhood, whereas the latter is impossible without the effective exchange of information and commodities, without a deep division of labor within a society, without a unified economic space.

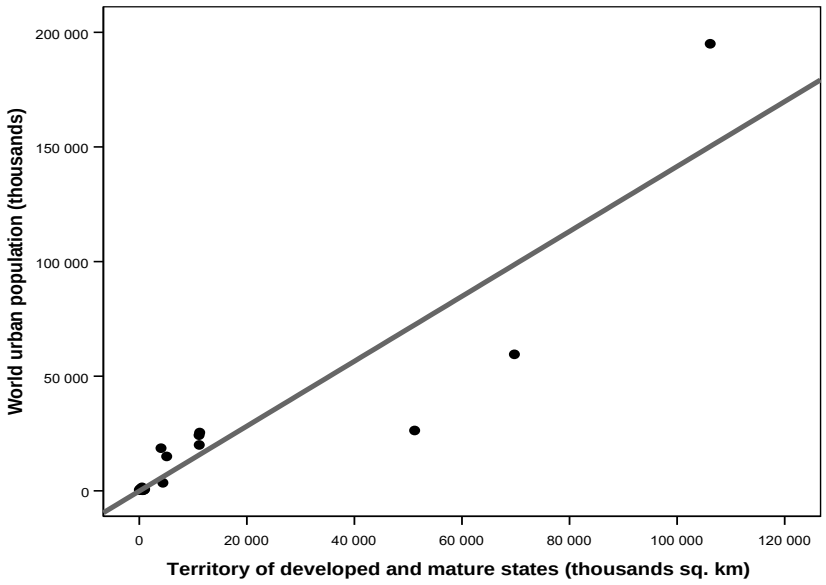
Let us consider now the relationship between the size of the territory controlled by the developed and mature states and their analogues, on the one hand, and the world urban population, on the other (see Diagrams 1 and 2):

Diagram 1. Dynamics of World Urban Population (thousands) and the Size of the Territory Controlled by the Developed and Mature States and Their Analogues (thousands km^2), 1000 BCE – 1900 CE



NOTES. Data on urban population for cities with > 10,000 inhabitants. *Data sources*: for the city population (for all the diagrams used in this article) – see Korotayev's article in this issue of the Almanac. The dynamics of the size of the territory controlled by the developed and mature states and their analogues have been calculated on the basis of Tables 1 and 2 of the article by Grinin and Korotayev in the present issue of the Almanac, Taagapera's database (Taagapera 1968, 1978a, 1978b, 1979, 1997), the database *Historical Atlas of Eurasia* (http://www.openhistory.net), and the *Atlas of the World History* (O'Brien 1999) for all the diagrams of the present article.

Diagram 2. Correlation between World Urban Population (thousands) and the Size of the Territory Controlled by the Developed and Mature States and Their Analogues (thousands km^2), 2100 BCE – 1900 CE (scatterplot with fitted regression line)



NOTE: r = + 0,916; p << 0.0001.

As we see, we do observe a really strong positive correlation between the two variables in question. However, the relationship between them is in no way identical with a simple linear relationship, which is especially clear if we consider the dynamics of the respective variables in a logarithmic scale (see Diagrams 3 and 4):

Diagram 3. Dynamics of World Urban Population (thousands) and the Size of the Territory Controlled by the Developed and Mature States and Their Analogues (thousands km^2), till 1900 CE. **(logarithmic scale)**

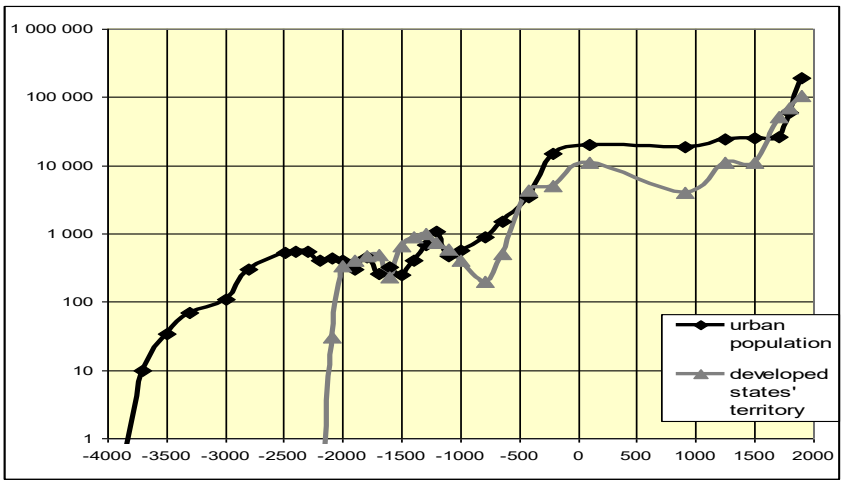
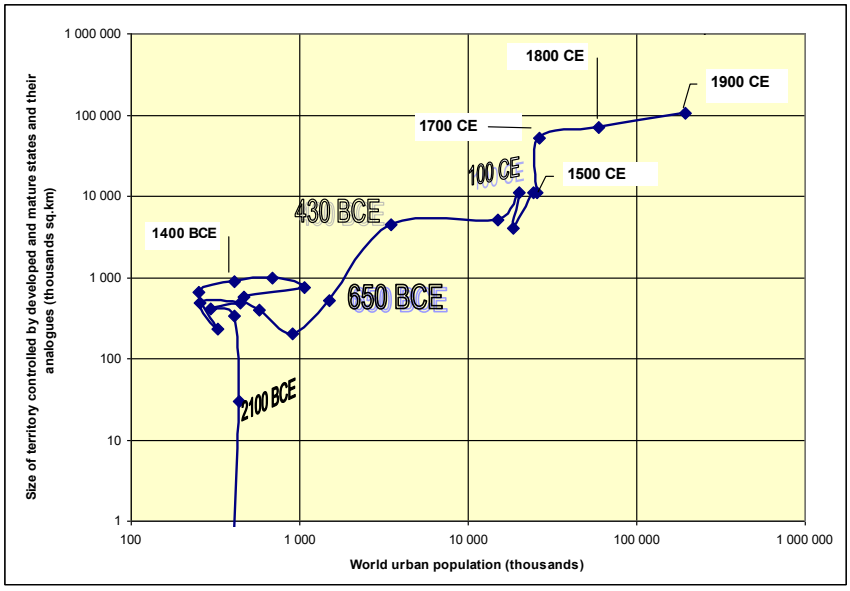


Diagram 4. Correlation between the World's Urban Population (thousands) and the Size of the Territory Controlled by the Developed and Mature States and their Analogues (thousands km^2), 2100 BCE – 1900 CE **(phase portrait in logarithmic scale)**



As we see, the formation of the first cities and the first phase of fast growth of the world urban population was observed in the 4th and early 3rd millennia BCE well before the formation of the first developed states and were connected with the development of early states and their analogues. However, already the formation of the first developed state (in Egypt in the mid 2nd millennium BCE) affected the World System urban population dynamics in a rather significant way. Indeed, after the millennial stagnation of the world urban population at the 300–500 thousand level, in the third quarter of the 2nd millennium we observe a period of relatively fast growth of the world urban population that, according to Modelski's (2003) estimates, in the 13th century exceeded (for the first time in the human history) one million. Note that this was, to a very considerable degree precisely due to the growth of Egyptian cities. It was in Egypt where the largest world cities were localized in the second half of the 2nd millennium BCE.[7] On the other hand, the decline of the developed Egyptian state in the late 2nd millennium BCE contributed in the most significant way to the decline of the world's urban population that was observed at this time.

In general, with respect to the dynamics of the territory controlled by developed and mature states and their analogues, we find the same system of attractors and phase transitions that was found earlier (see Korotayev's article in this almanac) with respect to the world's urban population, literacy, and political centralization. With respect to this variable[8] we also observe a phase transition in the 1st millennium BCE, as a result of which the size of the territory controlled by the developed states and their analogues grew by an order of magnitude up to around 10 million km^2, and had found itself in a new basin of attraction, within which it fluctuated till the phase transition of the Modern Age.

On the other hand, notwithstanding all the impressive synchrony of the phase transitions with respect to all the above mentioned indicators of the World System development, it is impossible not to note here a few important time lags during the phase transition of the 1st millennium BCE the surge in the size of territory controlled by the developed states (and, in general, the transition from the early to developed statehood at the scale of the World System) lagged behind the phase transition in the dynamics of the World System urban population and urbanization.

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[7] In the meantime this was also connected with the growth of the area of early states and the general strengthening of these states as a result of the development of bronze metallurgy (*e.g.*, in Achaean Greece, West Asia [Urartu, Mitanni, Assyria], and China). Thus, we observe close links between the development of new technologies, on the one hand, and statehood and urban expansion, on the other. We also observe close links between the development of the early state and urban growth. However, the fact that the largest world cities were concentrated in the third quarter of the 2nd millennium precisely in the first developed state, in Egypt, suggests that the links between urbanization and statehood acquired new characteristics manifested in the correlation between the formation of megacities and the developed state. Note that the formation of the mature state also correlated with the formation of megacities with an order of magnitude higher population than the one found in the megacities in developed states.

[8] *I.e.*, size of the territory controlled by developed and mature states and their analogues.

This lag can be interpreted as evidence for the fact that at this time the economic development of the World System temporarily advanced beyond the World System's political development.[9] Consequently, the transition of a number of early states to developed statehood (or its analogues) can be considered as dragging the level of political development up to the level of socio-economic subsystems that had advanced beyond the political ones with respect to their complexity. We believe that the formation of both early statehood and of developed/mature statehood implies a certain basis without which its development becomes impossible.[10]

In the meantime one should take into account the following points that account for the lag in the growth of developed states and also account for the advance of economic subsystems over political subsystems during the 1st millennium BCE.

1. The growth of developed statehood (and its analogues) is only an (advanced) component of the whole politogenesis process of the respective period. Political change (as well as change in other World System characteristics) occurred unevenly. Some societies develop early statehood whereas others move to the chiefdom level of political organization. In the period in question a very substantial part of the World System (especially at its periphery) had no statehood at all. Further growth toward developed statehood became possible only after the formation of early statehood in stateless parts of the World System (for example in most areas of Europe). However, for a long period of time this was not possible due to the lack of some necessary technologies (first of all, the development of iron technology).

2. However, the slow down of political development was not total. On the one hand, between the 16th and 7th centuries BCE we do not observe the formation of newly developed states (see Table 1 in the previous article of the present Almanac); on the other hand, this was a period in which a large number of new early states and their analogues were formed (see, *e.g.*, Grinin *et al.* 2004, 2006). What is important is that within the World System of the 2nd and 1st millennia BCE, early statehood could not develop without being based on urbanization, trade and crafts.

On the one hand, this led to the lag between urbanization and developed statehood in the world. On the other hand, the transition of these early states to the developed statehood could not take place due to the underdevelopment of crafts and markets. One of the most important factors was the absence of true money whose presence would have enormously facilitated the formation of

[9] Note that within the theory developed by the second author of this article, the economic-technological component of the World System is denoted as the *production principle*, whereas its political component is denoted as the *type of political organization of societies* (see Гринин 2000, 2003, 2006a, 2006г; Grinin 2006).

[10] As was noted above, in most cases such an economic basis was either directly connected with the city formation, growth, and concentration (and the urbanization process as a whole), or it was connected with such processes that contribute to the urbanization in some way or another, or depend on it.

trade connections throughout very large territories. Another (and even more important) factor was the absence or underdevelopment of new technologies (both military and non-military) – first of all, of iron metallurgy.

Naturally, it appears necessary to take into account the fact that the transition to iron metallurgy did not lead automatically to the transition to developed (and even early) statehood, because this transition can only take place when a number of conditions are present.[11] However, without iron metallurgy the expansion of developed statehood was strongly hindered; consequently, at this time, the formation of developed statehood was only observed under exceptional circumstances.

As was mentioned in the previous article of the present Almanac, the first states appeared within the World System (as well as, naturally, in the world in general) in the 4th and early 3rd millennia BCE (see, *e.g.*, Виноградов 2000б: 150–151; Дьяконов 2000а: 45–56; Baines and Yoffee 1998: 199; Wright 1977: 386; 1998; Ламберг-Карловски 1990: 7). They appeared on the basis of intensive irrigated agriculture. Thus, there are certain grounds to connect state formation with the finalization of the agricultural revolution. However, an important theoretical clarification is necessary at this point, as this clarification is important for the explanation of the above mentioned time lag between the World System phase transition along the urbanization dimension and along the dimension of the expansion of developed statehood. We believe that the agrarian revolution is one of three major production revolutions (in addition to the industrial and information-scientific revolutions). These revolutions were the most important technological and economic benchmarks of the World System development. However, at the World System level each of these revolutions occurred in two phases (for more detail see Grinin 2006). As regards the agrarian revolution, its first phase was connected with the transition to primitive (hoe) extensive agriculture and primitive herding, whereas its second phase involved the transition to irrigated or non-irrigated plow agriculture. In general, the second phase of the agrarian revolution may be regarded as the transition to the intensive and/or partly labor-economizing agriculture, that is, to the agricultural systems that radically increased the productivity of land and/or the productivity of labor in the land cultivation during critically important ("busy") seasons of the year. For the sake of brevity this second phase of the agricultural revolution will be denoted below simply as "intensive"[12].

[11] Including new administrative and political technologies, a certain level of social and ethnic development, elaborated law and court system, property relations, developed ideologies, strong economic links and so on. Thus though iron items began being used occasionally rather early (for example, among the Hittites), among other things for military purposes, this was not sufficient for the transition to the developed statehood.

[12] Irrigation made it possible to increase in a rather radical way the agricultural output from the given territory. This was not accompanied necessarily by the growth of the productivity of labor that rather tended to decrease due to the growing population pressure and diminishing returns. However, this decrease tended to be compensated by the increase in the working hours per day [see, *e.g.*, Boserup 1965; Коротаев 1991]). With transition to non-irrigated we observe the growth of productivity of labor in the land cultivation, as due to the use of the energy of draft animals one

Note that the gap between these two phases occupied a few millennia (between the 8th and 4th millennia BCE). Primary state formation should be connected with the second ("intensive") phase of the agrarian revolution.[13] However, a theoretically important point is that in the areas of large subtropical/tropical rivers and soft soils the transition to irrigated agriculture (that formed the economic basis for the development of states and civilizations) did not generally need any specialized new tools and materials (for example, metals). What is more, the tools themselves sometimes remained rather primitive. In such cases the most important component of the second phase of agricultural revolution was connected not with the tools, but with irrigation techniques, improved domesticates, agronomic know-how that made it possible to bring fertile lands under cultivation, or to increase significantly the productivity of land. On the other hand, in the 4th millennium BCE (or even a few centuries earlier) new tools (as well as the beginning of the economic use of a new energy source) still in the form of primitive scratch-plows and the use of oxen (with the help of yokes) for plowing and transportation (see, *e.g.*, Чубаров 1991; Краснов 1975; Шнирельман 1988). Of course, this was a very significant technological advance. However, it appears necessary to emphasize that the primary state formation was not strongly connected either with the invention of the plow, or the use of the energy of the draft animals.[14]

However, natural environments with soft and fertile soils that are liable for irrigation where productive agriculture (that is able to support supercomplex

person turns out to be able to cultivate much more land within the given period of time than when he or she relies on his or her own energy only. This, however, could lead to a certain decrease in the productivity of a given unit of land, as the hand cultivation of land tended to be more thorough. A radical increase in the productivity of land can be achieved in numerous ways; however, for the given period of time such an increase (that made it possible to move to a higher level of complexity) was achieved within sufficiently large areas mainly through the introduction of relatively large scale irrigation schemes. In some regions (for example, in certain areas of Central and South America) the transition to the intensive agriculture was achieved through the selection of especially productive varieties of domestic plants. A significant increase, in the productivity of labor could be also achieved in a variety of ways, however, the way that was particularly important for the transition to a new level of social and technological complexity (that could serve as a basis for the development of civilizations, states and their analogues) was the way of "mechanization", that is the use of plows with the metal (and, especially, iron) working part and draft animals, that made it possible to bring under cultivation much more amounts of land (including very substantial portions of marginal lands). Naturally, we observe a very considerable number of local variations of both the first and second phases of the agricultural revolution; what is more, in some places we find three phases (and just one in still other areas). It is at the scale of the World System as whole that it turns out to be appropriate to speak about just two phases of the agricultural revolution.

[13] Ernst Gellner (1984: 115) believes that a large gap between beginning of food production and state formation is "specifically disastrous" for those theories that connect the state formation and the agricultural revolution. Note that the above discussed point eliminates this objection.

[14] The fact that states and civilizations existed for many centuries supports this statement. *In principle*, in specific environments the state formation and primary urbanization could take place without metal tools and draft animals, on the basis of various irrigation and agricultural selection techniques (*e.g.*, Кузьмищев 1985: 126).

political structures) is possible without metal tools are rather limited. And what was possible in some Near Eastern areas on the basis of simple predominantly non-metallic tools (the formation of civilizations, cities, early, and later developed, states and their analogues) was simply impossible in most other areas of Asia, Europe, and Africa. In most of these areas the formation of supercomplex political structures became possible only after a qualitatively new level of technological development had been achieved (in particular, after the introduction of the iron metallurgy). Thus, the spread of civilization, urbanization, and statehood to many territories was hindered by the lack of iron metallurgy (and some other technologies). These technologies were invented in the late 2nd and 1st millennia BCE, and diffused throughout the World System in the 1st millennium BCE (note that they only reached many of its peripheral parts in the second half of this millennium).[15]

Only the introduction of plows with iron ploughshares in conjunction with effective draft animals and harnesses made it possible to carry out the second phase of the agrarian revolution in most parts of Eurasia. The new civilization only proliferated to most parts of the Old World with the invention of iron metallurgy; for example, in Sub-Saharan Africa civilizations only developed after the introduction of the hoes with iron working parts which, using Satton's (Саттон 1982: 131) expression, led to prosperity (see also Шинни 1982; Куббель 1982; Sellnow 1981). Effective agriculture only occurred in the Ganges Valley with the introduction of iron tools (Шарма 1987: 363).

In most parts of Eurasia the second phase of the agrarian revolution was connected with the introduction of iron tools, heavy plows (or light plows with iron ploughshares), as well as effective harness for draft animals.[16] The very principle of plow agriculture was borrowed by Europeans from West Asia, but in Europe the plow was significantly improved. This version of the second phase of the agricultural revolution was prevalent in Eurasia and North Africa in the areas of non-irrigated agriculture.

Yet, when these technologies (and with them the early statehood and its analogues) spread to new territories, the above mentioned lag between urbaniza-

[15] Occasional iron production was already known in the 3rd millennium BCE, however, more or less effective technologies of low-quality steel production were developed in the mid 2nd century BCE, most likely in Asia Minor (see, *e.g.*, Чубаров 1991: 109). The iron metallurgy got some development within the Hittite state that kept its monopoly over it; however, this technology remained rather primitive. The breakdown of the Hittite Kingdom led to the end of this monopoly and to the beginning of the diffusion of the iron metallurgy throughout the World System (Граков 1977: 17; Гиоргадзе 2000: 122–123; Дьяконов 2004: 400). In the early 1st millennium BCE (and especially in the first half of this millennium) the iron metallurgy already diffused rather widely throughout the Middle East and Europe (Чубаров 1991: 109, 114; Граков 1977: 21; Колосовская, Шкунаев 1988: 211–212; Дэвис 2005: 61; Златковская 1971: 47). In particular, Greece became a major iron producer within the East Mediterranean region already in the 10th century BCE (Андреев 1988: 221).

[16] There were other versions. For example, in pre-colonial Tropical Africa we observe the combination of the iron metallurgy and extensive hoe agriculture. However, the latter slowed down the statehood development in a rather significant way.

tion and developed statehood was temporarily amplified. According to the theory proposed by the second author of this article (see the previous article in the present issue of the Almanac), developed statehood can only appear within a territory that has been prepared for this historically, culturally, and economically; and such a preparation needs a considerable period of time. Objectively, urban growth prepared the formation of developed statehood and its proliferation to new territories, whereas cities, serving as economic and political centers, created a network that was necessary for a new phase transition that involved the rise of the World System to a qualitatively new level of complexity.

Let us return now to an earlier period when the proliferation of developed states lagged behind the formation of new early states and their analogues (*i.e.*, between the 2nd millennium BCE and the 1st half of the 1st millennium BCE). Already in the Bronze Age, in the late 3rd millennium BCE we observe in the Near East a complex model of cultural interaction between societies stretching from the Mediterranean to the Indus Valley, and the Central Asia to the Persian Gulf (see, *e.g.*, Ламберг-Карловски 1990: 12). As a result, we observe the formation of cities, early states, and their analogues in territories that were adjacent to the centers of first Near Eastern civilizations (and first developed states and their analogues) on the basis of soils that were relatively easy to cultivate, copper and bronze metallurgy, international division of labor, trade and so on. However, the formation of developed states in these territories was still highly problematic without the wide proliferation of iron metallurgy, military modernization (based on iron), and other technological and economic improvements.

It appears necessary at this point to answer the following question: why during this period did a developed state appear in Egypt (and its analogues – in Mesopotamia)? One has to mention here, first of all, the extremely high productivity of agriculture that tended to result in very high population densities, implying the need for a mode of administration relying more on bureaucratic processes rather than on a military apparatus.[17] A different situation was observed in the World System semiperiphery and periphery, neither of which possessed such productive agricultural resources. In these areas the military component of the state played a more important role. Consequently, developed states (and their analogues) could only appear here when there was a new productive basis that necessitated a greater economic consolidation of the respective territories. Other versions of developed states could appear either on the basis of profitable trade and the creation of considerable wealth in non-agricultural sector (that made it possible to import food resources in considerable quantities as it was observed in Athens), or on the basis of considerable technological improvements in agriculture that could make it as productive as it was in Egypt and Mesopotamia in the 3rd and 2nd millennia. In most places this

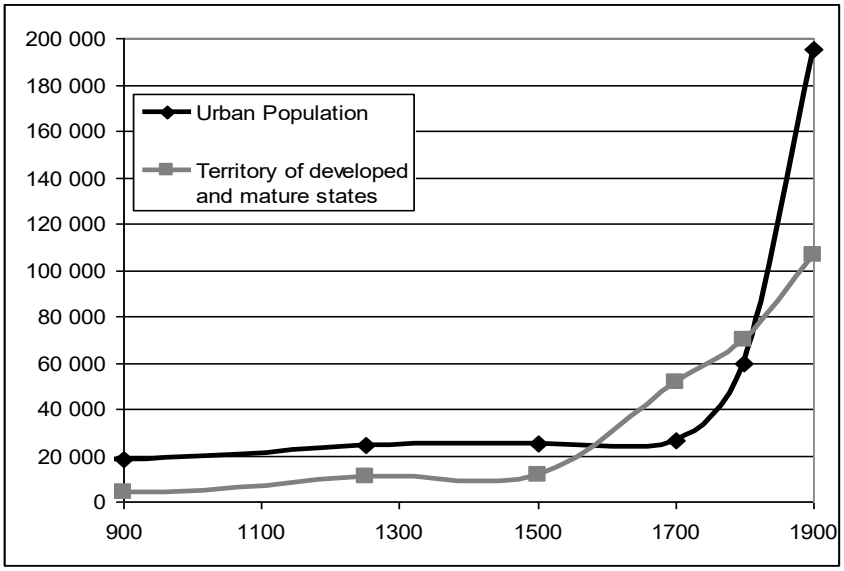
[17] A significant role was also played by the special geographic position in the large river valleys (with respect to Egypt see the article by Grinin and Korotayev in the present issue of the Almanac).

only became possible after the introduction of iron instruments in agriculture, crafts, and military sector (that was accompanied by a considerable number of other technological and strategic innovations), as well as vigorous development of trade (that also implied a qualitative development of money and credit instruments) and sea transportation.[18]

Thus, in the 2nd millennium BCE and the first half of the 1st millennium BCE the potential of economic and military-technological basis for the formation of new developed states without iron metallurgy and other new technologies turns out to have been entirely exhausted, whereas it took the new technologies a considerable period of time to diffuse throughout the World System; this seems to partly account for the developed statehood formation (and diffusion) lagging behind the world urbanization processes.

During the Modern Age phase transition, the rapid increase in the size of territory controlled by developed (and mature) states had begun a considerable time before the start of an equally rapid and impetuous growth in the world's urban population. This increase in territory and urban population growth becomes especially clear if we consider the dynamics of these variables within the 2nd millennium CE (see Diagram 5):

Diagram 5. Dynamics of the World Urban Population (thousands) and the Size of the Territory Controlled by the Developed and Mature States and Their Analogues (thousands km^2), 100–1900 CE



[18] As was mentioned above, this process also implied the development of new administrative-political technologies, social, ethnic, and ideological relations.

As we can see, during Phase Transition A3 the impetuous growth of the territory controlled by developed states had begun two centuries before a comparably impetuous growth in the world urban population began. The impetuous growth of this territory in the 16th – 18th centuries was connected, first of all, with the formation of the developed statehood in the Ottoman Empire, Mughal India, and Russia, the restoration of the developed statehood in Iran, as well as with a vigorous territorial expansion of the developed states of Asia (Qing China, Mughal India, Sefevid Iran, the Ottoman Empire), as well as the expansion of Russia (that put under its control immense territories in Siberia) and a few West European states (note that some of them were already being transformed into mature states) that began an active overseas expansion (which we will consider in more detail below).

This lag needs special comments as it is connected with some specific features of developed states. On the one hand, these states create solid political and non-political links within the respective societies (for more detail, see Гринин 2006а; 2006в; 2006д); within these networks an especially important role was played by large cities, and especially capitals whose population could be very high for agrarian societies. For example, Istanbul, by 1500 the largest city in Europe, had "achieved the size of the largest city in East Asia (Beijing) by 1550" (Chase-Dunn and Manning 2002: 387), with a population between 400 500 thousand (Петросян 1990: 72–73, 103). Note, however, that the population of the largest world cities of the 8th and 9th centuries, Chang'an and Baghdad, appear to have been even larger (Modelski 2003: 150–151, 184).

On the other hand, one should not forget that the developed states of this period were predominantly agrarian. That is why the leaders of such states were frequently interested in the creation of cities as military centers and outposts (as was done, for example, by the Russian state during its southward expansion to the steppe region) and were not always interested in the further extensive growth of their urban populations, especially in capitals where unruly elements of the swelling urban population could threaten state stability. In addition to this, developed states usually have a high military potential that makes it possible for them to undertake vigorous expansion to underdeveloped peripheries. However, such expansion frequently involves underpopulated territories (as, *e.g.*, with the Russian expansion into Siberia, or the Qing expansion to Eastern Turkestan and Tibet); these territories, it goes almost without saying, were usually either underurbanized, or totally unurbanized.

The most important point is that in these states the main product was still agricultural produce. According to Neomalthusian models, the population of such states tended to their carrying capacity. Their political-demographic dynamics are characterized by the so called "secular cycles"[19] that include recov-

[19] As these cycles are of an order of 1–2 centuries, it was suggested by Turchin (2003, 2005b) to denote them as "secular cycles".

ery phases, phases of relative overpopulation, and phases of political-demographic collapses that resulted in state breakdowns and precipitous population declines (see, *e.g.*, Goldstone 1991; Turchin 2003, 2005a, 2005b; Turchin and Korotayev 2006; Nefedov 2004; Малков и др. 2002; Малков, Селунская, Сергеев 2005; Korotayev, Malkov, and Khaltourina 2006a, 2006b; Korotayev and Khaltourina 2006). The second author of this article has come to the conclusion that though the carrying capacity was always limited, the above mentioned distinct secular cycles were typical precisely for the developed states (and much less typical for the early states [Гринин 2006б]). This is accounted for by the fact that, in contrast to early states, developed states are normally able to support order within large territories, as well as economic development, trade, and monetary circulation for long periods of time. This makes it possible for the respective populations to approach rather closely the carrying capacity ceiling.

These political-demographic cycles produce an ambivalent influence on urban population dynamics. On the one hand, during the relative overpopulation phases, a considerable part of the rural population tends to be pushed from the countryside to the cities, which stimulates urban growth. As has been shown by Nefedov (2004) with respect to China, relative overpopulation led to land shortage, and to the loss of their land by considerable number of peasants. However, only some peasants who lost their lands became tenants. Indeed, it does not make sense for a landlord to rent out his land in plots barely sufficient to provide subsistence for a tenant and his family. As the standard rent rate in China was 50%, such plots would be at least twice as large. Hence, if two poor peasants having minimum size plots each have to sell their land, only one of them will be able to accommodate himself in his village as a tenant. The other will have to accommodate himself in some other ways. One of the possibilities was to find alternative employment in the non-agricultural sector, *e.g.*, in cities. As was suggested by Nefedov, the very process described above would in fact tend to create new possibilities for such employment, as landowners were more likely than poor farmers to buy goods produced in cities. This is confirmed by historical data indicating that the fastest growth of cities (and, hence, overall sociocultural complexity) tends to occur during the last phases of political-demographic cycles (see, *e.g.*, Nefedov 2004; Korotayev, Malkov, and Khaltourina 2006b: 86). On the other hand, in the supercomplex agrarian societies during the recovery growth phases (or in cases of significant growth of carrying capacity) the overall demographic growth rates were much faster than the rates of the urban population growth. Preindustrial cities (and especially large preindustrial cities) were characterized by the commoner mortality rates that were much higher than the ones observed in rural areas, whereas the average life expectancies in the cities were significantly lower than in the countryside. In fact, in many large preindustrial cities mortality rates exceeded fertility rates, in such cities the natural population growth rates were negative, and their demographic

reproduction took place due to the population influx from the countryside (see, *e.g.*, McNeill 1976; Storey 1985: 520; Lee and Wang 1999; Diamond 1999; Maddison 2001: 34). Consequently, when the rural populations had acceptable levels of life (which was observed during recovery phases, or when important technological innovations raised the carrying capacity sharply) the rural populations tended not to move to the cities, and the proportion of the city-dwellers in the overall population tended to decline (as was observed, for example, in Russia, or China in the 18th century [Нефедов 2005: 188; Korotayev, Malkov, and Khaltourina 2006b]).

The proliferation of developed statehood was an important component of the phase transition of the 1st millennium BCE and contributed in a rather significant way to the surge in the world's urbanization to qualitatively higher levels. Indeed, developed statehood makes it possible to sustain, within a given territory, a higher population (thus, it actually increases carrying capacity [Turchin 2003: 120–122]). Developed urbanization also "allows" the population to approach rather closely the carrying capacity ceiling, which, as was noted above, within the conditions of supercomplex agrarian societies stimulates urbanization. As a result, developed states are typically characterized by such values of both the overall urban population and urbanization level (that is, the urban population proportion within the overall population) that are significantly higher than those typical for the early states.

On the other hand, the "secular" political-demographic cycles that are so typical for developed states create, to a considerable degree, an "attractor effect". Indeed, at those cycle phases when a rather fast overall population growth was observed, cities grew relatively slowly, whereas urban growth acceleration was normally observed within those cycle phases when the overall population growth rates declined. Of course, the results of such urban growth differed dramatically from the one observed during the phase transition periods when urbanization growth was observed against the background of accelerating overall population growth rates (which, in fact, produces just the phase transition effect). In addition, during political-demographic collapses the urban population declined in an especially dramatic way; all these taken together produce precisely the effect of "wandering" around the B2 attractor, the attractor of supercomplex agrarian society (that is typically organized politically just as the developed state).

In general, during the 16th – 18th centuries, developed states could not secure such an urban growth that would match the extent of their territorial expansion. It is also entirely clear that at this time a solid basis for a phase-transition type of urban growth could only be created by a new, industrial, production principle, and not by the old craft-agrarian one. As its formation and proliferation took a considerable period of time, urbanization was bound to lag behind the territorial growth of the mature states. However, it should be taken into account that the accelerating growth of both the overall and urban population within the

developed states (even when it was not accompanied by a significant increase in the proportion of the urban population to the overall population), as well as the creation of a considerable number of new cities created a solid basis for the forthcoming industrialization phase and the concomitant explosive urbanization.

The growth of the developed states' territory was observed not only with respect to the Asian states, but also the European ones (first of all, with respect to Russia, Spain, Portugal, Austria, the Netherlands, and England). Note that in the last case this expansion is directly connected with the beginning of the transition to the industrial principle of production (Гринин 2003; 2006г). And already the first phases of this transition led to a rather significant progress precisely in those spheres (such as seafaring and military technologies) that contributed to the acceleration of territorial expansion of developed (let alone mature) states.

Notwithstanding all the apparent asynchronicity of the two processes in question, they were tightly interconnected. For example, the European colonial expansion played a critically important role in the introduction of New World domesticates to the Old World agricultural systems and the processes of primary accumulation of capital. These processes directly prepared the World System to agricultural modernization and the industrial revolution that began in the late 18th century. Precisely the combined actions of agricultural modernization and the industrial revolution led to the explosive growth of the world urban population during Phase Transition A3.[20]

The tight interconnectedness of the dynamics of developed statehood and the urbanization of the World System looks especially salient if we consider the population dynamics of megacities (that is, cities with more than 200 thousand inhabitants each) (see Diagrams 6 and 7):[21]

[20] Rather large cities occasionally developed also in the New World. For example, in the 16th century in Bolivia a rather large city, Villa Imperial de Potosi formed as a center of silver amalgamation industries (according to some estimates, its population at its peak could reach 120 thousand [Бакс 1986: 123]).

[21] Note that, due to the fact that in this case we have a considerable number of data points at our disposal, we can observe better the cyclical and stochastic components of the dynamics of the variables in question during the era of supercomplex agrarian societies, that is, their fluctuations around Attractor B2.

Diagram 6. Dynamics of the World Megacities' Population (hundreds) and the Territory of the Developed and Mature States and Their Analogues (thousands km^2), till 1900 CE

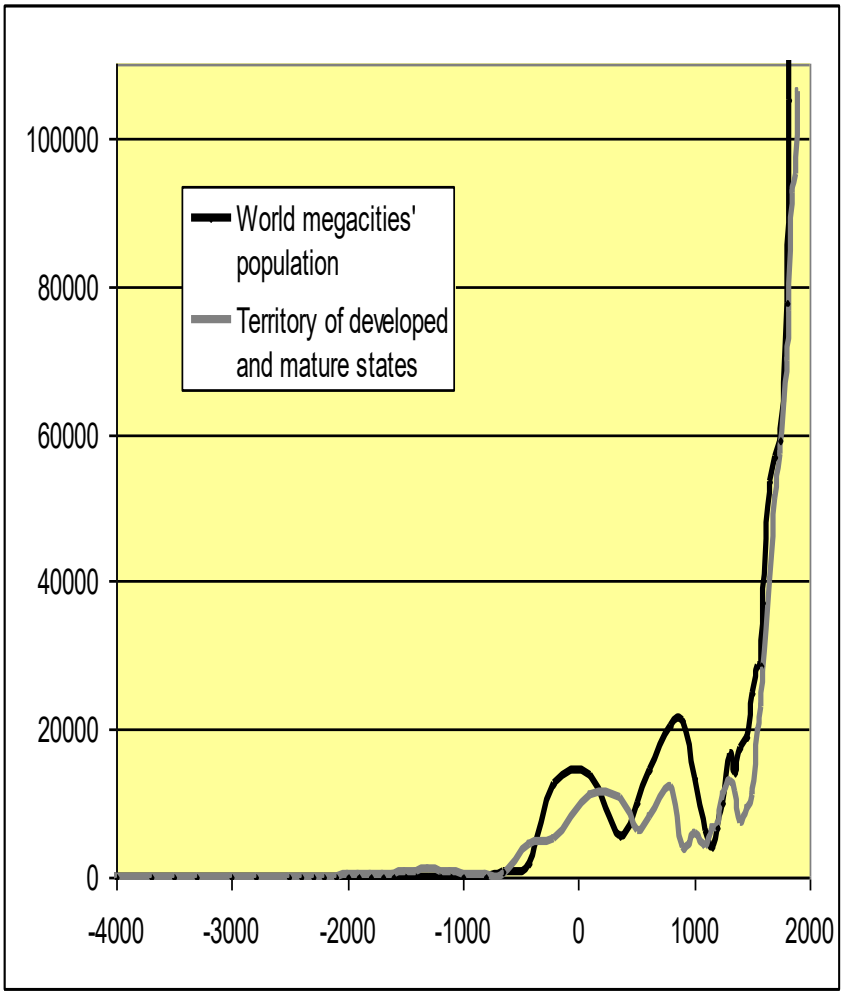
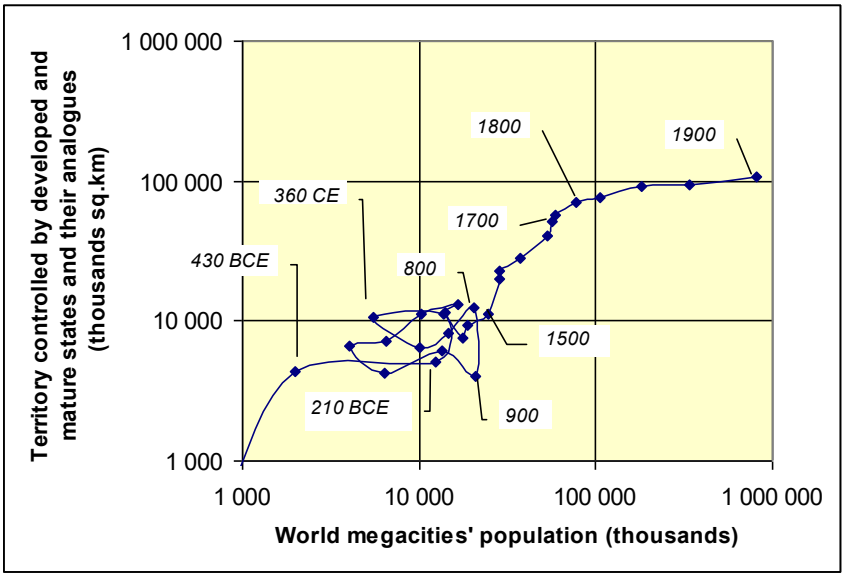


Diagram 7. Correlation between the World Megacities' Population (hundreds) and the Territory of the Developed and Mature States and Their Analogues (thousands km^2), 2100 BCE – 1900 CE **(phase portrait in double logarithmic scale)**



As we see, the synchronism of the phase transitions is expressed here even more clearly. Cities with more than 200 thousand inhabitants first appear in the second half of the 1st millennium BCE quite simultaneously with the impetuous growth of territory controlled by the developed states that was observed in precisely the same period of time. Stabilization of the size of this territory at a level around 10 million km^2 in the early 1st millennium CE was accompanied by the stabilization of the World System's[22] megacities' population at a level around 1 million. Thus, both variables found themselves simultaneously in the attraction basin of the supercomplex agrarian society (B2). What is more, they started their movement from this basin of attraction in a rather simultaneous way, in the second half of the 15th century (to a considerable extent in connection with the beginning of the World System transition to the industrial production principle [see, *e.g.*, Гринин 2003; 2006a]).

[22] Note that all the world megacities (that is, the cities with more than 200 thousand inhabitants) were always situated just within the World System.

We believe this synchronicity is not coincidental at all. The point is that the preindustrial megacities were, to a considerable degree, a creation of the developed statehood.

Developed statehood is generally impossible without megacities that act as its core (for more detail see Гринин 2006a). On the other hand, these were just the large developed states that could support the megacities' reproduction in the preindustrial epoch. What is more, such states naturally created megacities. Indeed, the formation of developed statehood implied growth of the administrative apparatus complexity (including, naturally, the complexity of the central administrative apparatus) by an order of magnitude.

Hence, the capital of a large developed preindustrial state had to accommodate this complex central apparatus, which implied the presence in such a capital of not only a very large number of administrators and auxiliary technical staff, but also of an even larger number of craftsmen, merchants and service providers who were necessary to support the functioning of the former. As was mentioned above, such capitals tended to concentrate a substantial part of nobility (including even those of its members who were not at the state service) and military. In addition to this, developed statehood implies that the system of resource accumulation and redistribution through the administrative center is also more developed by an order of magnitude than in the early states, which led to a sharp increase in resource concentration levels within such centers. Especially high levels of resource concentration were observed in the administrative centers of the largest developed states, which attracted considerable numbers of people even if they were not engaged directly in serving the needs of the central administrative apparatus of such a state. Against this background it does not appear coincidental at all that the majority of megacities registered by Chandler's database prior to 1801 were nothing else but capitals of large developed/mature states-"empires". Note also that in general, out of 152 megacities (with > 200 thousand inhabitants) registered by Chandler's database prior to 1801, 134 megacities (*i.e.*, > 88%) were situated within the territory controlled by developed/mature states and their analogues (Chandler 1987: 461–485), which can be considered as additional evidence supporting the statement that the preindustrial megacites were created up to a very considerable degree just by the developed statehood.

Let us consider now the correlation between the dynamics of territory controlled by developed/mature states and the world's megaurbanization dynamics (that is, the dynamics of the world megacities' population as a proportion of the total population of the world) (see Diagrams 8–10):

Diagram 8. Dynamics of World Megaurbanization (proportion of megacities' population in the total population of the world, ‰) an the Territory Controlled by Developed/Mature States and Their Analogues (millions km^2), till 1950

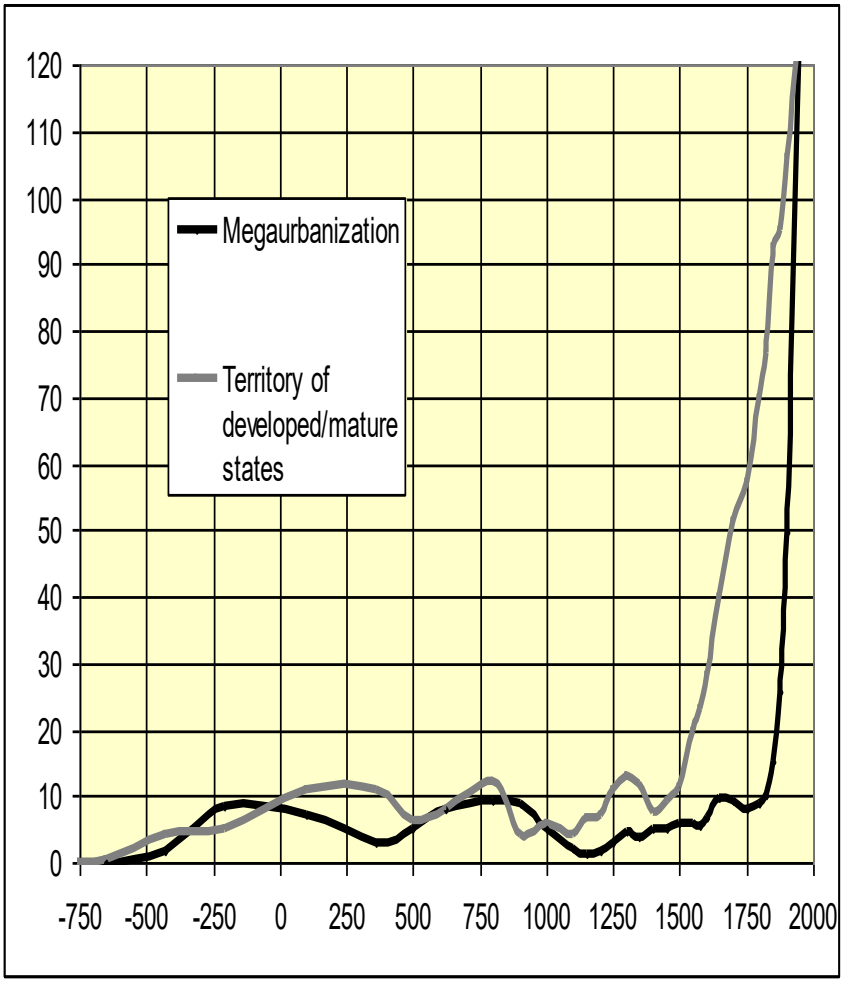


Diagram 9. Dynamics of World Megaurbanization (proportion of megacities' population in the total population of the world, ‰) an the Territory Controlled by Developed/Mature States and Their Analogues (millions km^2), 1250–1950 CE

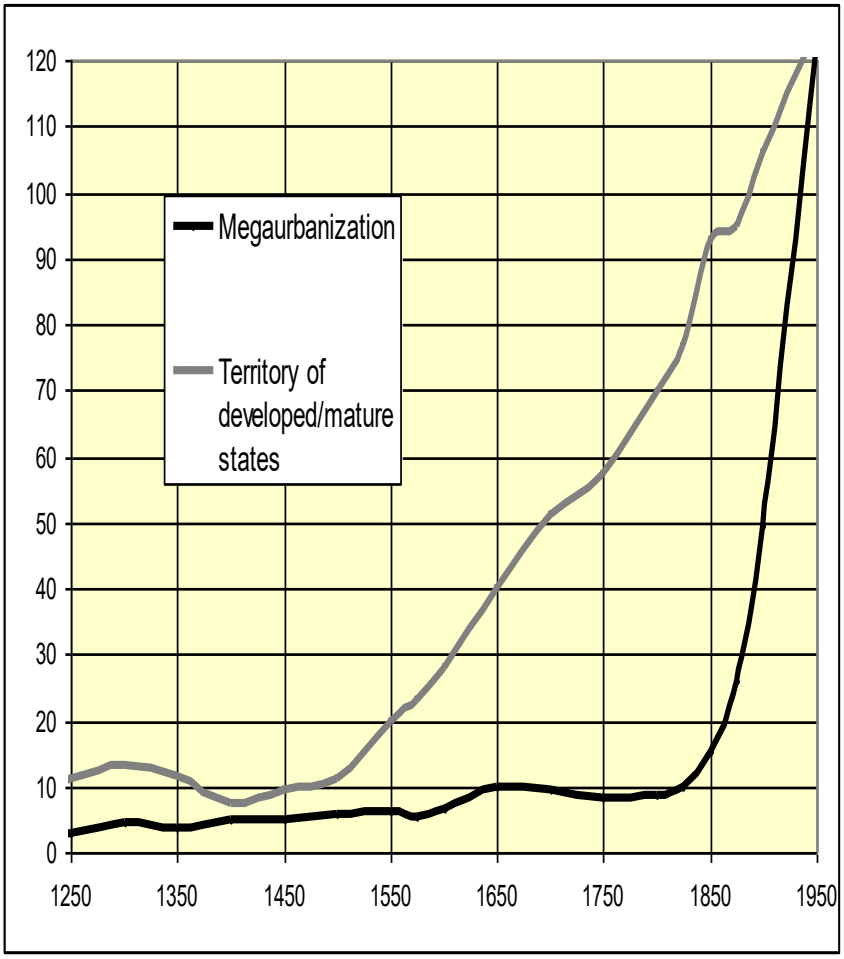
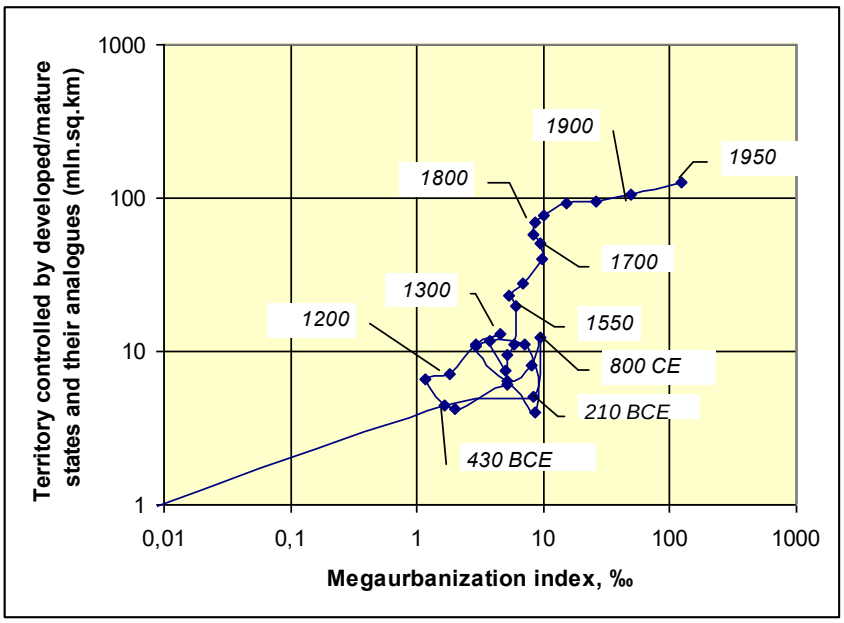


Diagram 10. Dynamics of World Megaurbanization (proportion of megacities' population in the total population of the world, ‰) and the Territory Controlled by Developed/Mature States and Their Analogues (millions km^2), till 1950 **(phase portrait in double logarithmic scale)**



As we see, the sharp increase in the territory controlled by developed states observed in the second half of the 1st millennium BCE was quite predictably accompanied by the formation of the first megacities. By the end of this millennium the world's megaurbanization rate had approached 1% (or 10‰), whereas the developed states' territory had reached 10 million km^2. After this the respective variables remained around this level for about a millennium and a half. The World System found itself within the supercomplex agrarian society attraction basin. The territory of the developed states started its movement from this basin of attraction in the late 15th century, that is, 300 years before the megaurbanization. This does not contradict the fact that the megacities' overall population started growing rather rapidly simultaneously with the start of the impetuous growth of the developed states' territory in the late 15th century. Let us recollect that those processes took place against the background of the hyperbolic growth

of the World System's population (Korotayev, Malkov, and Khaltourina 2006a). As a result, even though the world megacities' population grew by 215% between 1500 and 1800, its proportion in the overall population of the world (that is, the World System urbanization) increased by less than 50%. Thus, by the early 19th century with respect to its megaurbanization rate, the World System still remained within the attraction basin of the supercomplex agrarian society, which it only left and began its unequivocal movement (= phase transition) towards the next attractor in the 19th century.

This is quite explicable, because the second phase of the industrial revolution (the actual industrial breakthrough) had only begun, and by this time it had only embraced just one country – England (for more detail see, *e.g.*, Knowles 1937; Dietz 1927; Henderson 1961; Phyllys 1965; Cipolla 1976; Stearns 1993, 1998; Lieberman 1972; Манту 1937); hence, it had not proliferated sufficiently. In the meantime, the World System could only reach a qualitatively higher level of megaurbanization through adopting a new economic basis, whereas the development of this basis had not reached a necessary volume by the early 19th century. It somehow resembles the situation of the 2nd millennium BCE when the territories where the developed states could appear with the available (at that time) limited technological basis had been exhausted; similarly the potential of the megacities' development on the old supercomplex agricultural technological basis had been almost entirely exhausted by the 19th century and the further megaurbanization breakthrough became only possible through the World System transition to a new production principle, the industrial one.

Note that a similar picture is observed with respect to the overall world urbanization dynamics (that is, for the dynamics of the proportion of population living in cities with > 10 thousand inhabitants in the total population of the world) (see Diagrams 11–12):

Diagram 11. World Urbanization Dynamics (= dynamics of proportion of population of cities with > 10 thousand inhabitants in the total population of the world, %) and Dynamics of Territory Controlled by Developed/Mature States and Their Analogues (millions km^2), till 1950

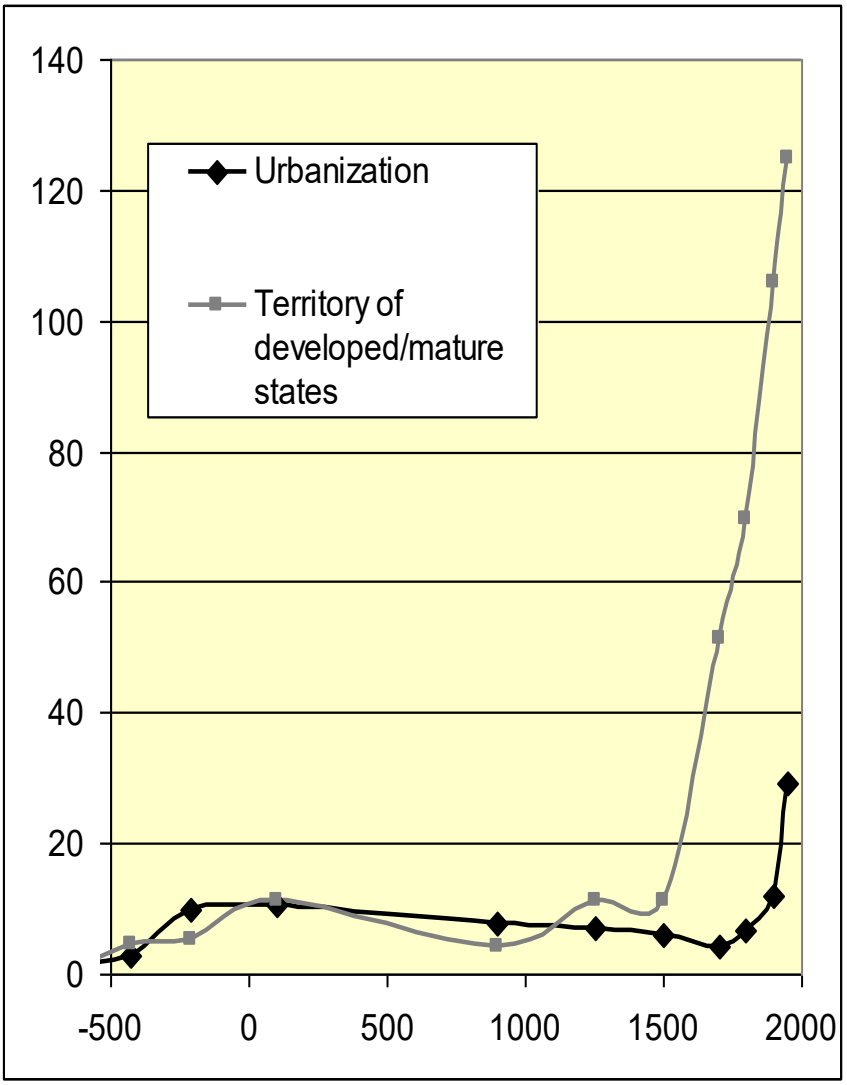
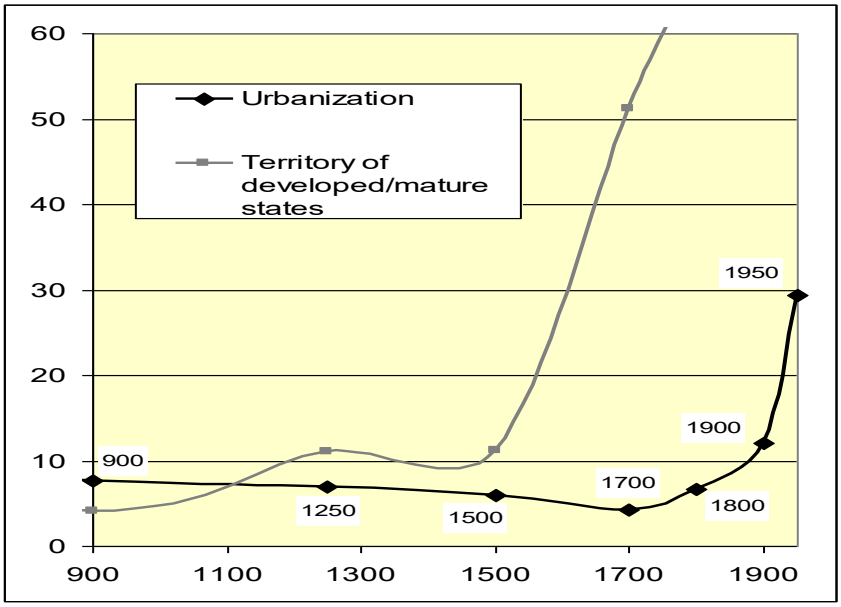


Диаграмма 12. World Urbanization Dynamics (= dynamics of proportion of population of cities with > 10 thousand inhabitants in the total population of the world, %) and Dynamics of Territory Controlled by Developed/Mature States and Their Analogues (millions km^2), 900−1950 CE



We would consider as a correlate to the urbanization explosion of the 19th and 20th centuries in the sphere of political development, not the growth of the territory controlled by the developed/mature states, but, instead, the wave of the formation, proliferation, and strengthening of the mature state that was observed in these centuries and that in the 20th century engulfed almost the whole of our planet (see Table 2 in the article by Grinin and Korotayev in the present issue of the Almanac). As regards the territory controlled by the developed and mature states, already in the late 19th century it came rather close to the saturation point (corresponding just to the territory of all the inhabitable landmass of our planet), which quite predictably led to a certain slow down in the rate of increase in the value of the respective variable.

Finally, we would like to stress that, from our point of view, **urbanization, on the one hand, and the growth of developed and mature statehood, on the other, are not just mutually connected and do not just influence each other (as was shown above) – but they are two different aspects of one process, the process of the World System development**. That is why it makes sense to conclude this article with a consideration of their interrelationships in

the framework of the general process of the development of the World System as a whole. The World System is an extremely wide suprasocietal system that unites a very large number of societies with various links that at the early stages of its development were mostly information (and only partly technological diffusion) links[23]. However, at later stages we observe the growth of the importance of political-military and economic links. Incidentally, the latter is connected with the development of new communication technologies. Consequently, the transition of the World System through each new stage of its evolution was connected with the development of the world's economy, trade, diffusion of new technologies and so on, and all of this, taken together, led to new waves of city growth. We can observe the following general regularities of World System development:

a) The very transition of it from one stage to another was prepared every time by such phenomena of its political and urban organization that were not systemic for an earlier stage of its development. And this is quite explicable, as new phenomena must develop within an earlier stage creating a new core for the diffusion of new systemic characteristics. Among other things this accounts for a considerable time lag between the formation of the first developed states and the proliferation of the developed statehood throughout the World System. In some areas (as in Egypt and Mesopotamia) a lead in the development of the political system relative to the overall level of World System development was possible; however, the further political development needed a considerable change of the World System as a whole.

b) The World System transition to a new stage produces a cumulative effect of the diffusion (through borrowing, modernization, forced transformation and so on) of new phenomena to those territories that failed to develop such phenomena independently.

c) The development of political and urban systems mutually reinforced each other, whereas for some period the lead belonged to the political development, while in the other periods it belonged to the development of the urban systems.

The first stage of the World System corresponds to the period of the World System formation and the developments of the first cities and complex

[23] The following commentary appears to be necessary here. Of course there would be no grounds for speaking about a World System stretching from the Atlantic to the Pacific, even at the beginning of the 1st millennium CE, if we applied the "bulk-good" criterion suggested by Wallerstein (1974, 1987, 2004), as there was no movement of bulk goods at all between, say, China and Europe at this time (as we have no reason to disagree with Wallerstein in his classification of the 1st century Chinese silk reaching Europe as a luxury rather than a bulk good). However, the 1st century CE (and even the 1st millennium BCE) World System definitely qualifies as such if we apply the "softer" information-network criterion suggested by Chase-Dunn and Hall (1997). Note that at our level of analysis the presence of an information network covering the whole World System is a perfectly sufficient condition, which makes it possible to consider this system as a single evolving entity (see Korotayev, Malkov, and Khaltourina 2006a, 2006b). Yes, in the 1st millennium BCE any bulk goods could hardly penetrate from the Pacific coast of Eurasia to its Atlantic coast. However, the World System had reached by that time such a level of integration that iron metallurgy could spread through the whole of the World System within a few centuries.

polities on its basis; it ends with Phase Transition A1 to the complex agrarian systems. It appears logical to connect it with the first phase of the agrarian revolution and the diffusion of its results. It corresponds approximately to the period between the 10th and 4th millennia BCE (including).[24] At the end of this period we observe the formation of the first states and a whole system of cities, whereas we find a rather complex urban society in the Near East (see, *e.g.*, Ламберг-Карловски 1990: 4). However, a real proliferation of both cities and statehood (as well as its analogues) is observed during the next stage.

The second stage of the World System development corresponds to the second phase of the agrarian revolution, or to the attraction basin of complex agrarian society (B1) and the beginning of Phase Transition A2 to the supercomplex agrarian society (the 3rd millennium – the first half of the 1st millenni-

[24] Naturally, we are speaking about the most advanced areas of the Near East for whom we date the first phase of the agrarian revolution to the period between the 10th/9th and 6th millennia BCE (see Гринин 2006г and Grinin 2006 g). It is quite clear that for the other regions these dates are quite different, but this is not important for us in the present context, as these areas were outside of the nascent World System during the period in question. What is more important looks as follows. We know the first stage of the World System development worst of all (at least due to the total absence of written sources for the period in question). Hence, this stage has been singled out just preliminarily. In reality, we appear to be dealing here with a few (or, at least, two) stages, that could be subdivided into substages. Indeed, there are certain grounds to suppose that the history of this period of the World System development (whose length exceeds the one of all the other periods taken together) had a rather complex structure. For example, one could suggest to single out the stage of the World System genesis (roughly the 10th – 6th millennia BCE). As was mentioned above, it could be connected with the first phase of the agrarian revolution in the Near East. The second stage (roughly the 6th – 4th millennia BCE) is connected with the wide diffusion of the agrarian revolution achievements, the pronounced expansion of the area of the agrarian production principle, the production diversification, significant growth of sociocultural complexity, increase in the quality and density of the World System links. It may be considered as the stage of the finalization of the World System formation. On the other hand, within the period between the 10th and 4th millennia BCE one can tentatively detect a certain system of attractors and phase transitions. First of all, in the 10th and 9th millennia BCE in the core of the nascent World System (within the Fertile Crescent) we are dealing with the phase transition from the intensive foraging societies to the simple agrarian ones (for the region in question the period of simple agrarian societies roughly corresponds to the Pre-Pottery Neolithic period) that took place (see, *e.g.*, Шнирельман 1986: 251; Kottak 2000: 280–282; Diamond 1999: 131–136; Kuijt 2000; C. Ember, M. Ember, and Peregrine 2002: 164–165). However, the World System protourban agrarian cultures of the 6th – 4th millennia could already be hardly called "simple" – as has been convincingly shown by Berezkin (1995, 2000), we are rather dealing here with medium-complexity agrarian societies the transition to which (very roughly corresponding to the transition from the Pre-Pottery Neolithic to the Pottery one) in the World System core areas appears to have taken place in the 7th and 6th millennia, when we observe the formation of a number of "protocities" (`Ain Ghazal, Beisamoun, Beida, Abu Hureira, Çatal Hüyük) with the estimated population of around 2000 (or more) each, which by an order of magnitude higher than the settlement size that is typical for simple agrarian societies (see, *e.g.*, Murdock 1967; note that this is why we prefer to denote those cultures that are typical for Attraction Basin B1 as "complex agrarian societies", whereas the ones typical for Attraction Basin B3 are denoted by us as "supercomplex agrarian societies"). Note also that if the hypothesis on the presence of the above described system of attraction basins and phase transitions of the World System in the 10th – 4th millennia BCE is confirmed, it will demand the reconsideration of not only the periods of its development, but also of the designations of its attraction basins and phase transitions.

um BCE). During Phase Transition A1 we observed the transition to intensive irrigation agriculture that provided a basis for the formation of the first states and the growth of cities. The processes of the new states and cities' formation (as well as processes of their disintegration, which created the attractor effect) continued during the whole of the B1 period. At the end of this stage, during Phase Transition A2, the agrarian revolution was finalized through the diffusion of effective plow agrarian technologies employing iron tools. As a result we observe the proliferation of economic links throughout very large parts of the World System, the extension of those links, and the formation of large areas of intensive growth. New political structures were developed, including the formation of the first really large-scale empires.

In the 2nd millennium BCE the first developed states appeared. However, their productive basis was restricted to a few river valleys which had a very fecund and thus special ecological environment.

The third stage of the World System development is a period where the of the agrarian civilizations' maturity, which correspond to the end of Phase Transition A2 and the attraction basin of the supercomplex agrarian society (B2). This is a period starting in the second half of the 1st millennium BCE and ending in the first half of the 2nd millennium CE. At the beginning of this stage the proliferation of developed statehood eliminated its lagging behind urbanization, and we see that in the process of Phase Transition A2 (in the 1st millennium BCE) it acquired a solid territorial basis and a considerable degree of stability. Indeed, notwithstanding the breakdowns that a number of developed states experienced within Attraction Basin B2, during the respective period (the 1st millennium CE and the first half of the 2nd millennium CE) the overall territory (and population) controlled by the developed states remained within the same order of magnitude. This suggests a state of relative stability of the World System as a whole, notwithstanding all the dramatic perturbations that were observed in its various constituent parts. As a result the World System fluctuated in the vicinity of Attractor B2 up to Phase Transition A3.

However, at the end of this period we observe important changes in urban development in cities of the World System. In the first half of the 2nd century CE this is clearly manifested in the appearance of a very large number of new cities in Europe (both in its West and East) and a rather intensive overall urban growth in this part of the World System. It should be noted that in many parts of Europe cities developed as autonomous settlements specializing in crafts and trade, and this played an important role in the further development of the World System. However, the cities grew not only in Europe, but also, for example, in Central Asia; a long-term term trend towards urban growth can be traced in the 10th – 16th centuries in China;[25] cities appeared and grew in many areas that were integrated in the World System during the period in question – in Japan,

[25] On the other hand, it is necessary to note the absence of any significant urban growth (even as a trend) during the whole period in question in some most ancient World System centers, for example, in Egypt and Levant (Большаков 2001).

South-East Asia, at the East African coast, in the African regions immediately South of the Sahara, and so on (see, *e.g.*, Chandler 1987; Wilkinson 1993). A system of land trade routs (that effectively connected most constituent parts of the World System) was established throughout the territory of the Mongol States. At the end of the period, in the 13–15th centuries for the first time after the breakdown of the Roman Empire, we observe the formation of developed states (that played a very significant role in the subsequent development of the World System) in Europe. Protoforms of a new type of economy were formed in a belt stretching from Northern Italy through Southern Germany to the Netherlands (see, *e.g.*, Bernal 1965; Wallerstein 1974).

The fourth stage of the World System development is a period from the 15th century up to the early 18th century, which corresponds to the final period of the World System development within the attraction basin of the supercomplex agrarian society (B2), the period of the completion of accumulation of those conditions that were necessary for the start of Phase Transition A3. This stage is connected with the start (the first phase) of the Industrial Revolution and the great geographic discoveries that gave a powerful impetus to World System development. First of all, the World System experienced a radical territorial expansion; secondly, it transformed into what Wallerstein (1974, 1980, 1987, 1988, 2004) denotes as the capitalist world-system, as its constituent parts started to be connected more and more with the bulk commodity exchanges. During this period the main World System changes were directly connected not so much with the growth of the cities as base stations and communication network nodes within the old borders of the World Systems, but rather with sea-born expansion to new lands, which became only possible through the development of ship-building and navigation technologies.

During this period urban growth appears to have been connected first of all with political processes, especially with the above mentioned proliferation and strengthening of developed statehood (i.e., the formation of developed capitals, growth of regional megacities, and so on). Urban growth was also connected with the formation of a developed statehood and the strengthening of internal markets; whereas the Modern Age formation of developed statehood also implied a certain industrial development in connection with the so-called "Military Revolution" of the 16th and 17th centuries (see, *e.g.*, Пенской 2005; Duffy 1980; Downing 1992).

At the end of this period we observe the formation of the first mature states and the first industrial zones.

The fifth stage of the World System development corresponds to the first part of Phase Transition A3 and is directly connected with the second phase of the Industrial Revolution (*i.e.*, with the industrial breakthrough of the 18th and 19th centuries), but especially with the development of transportation and communication technologies that raised by orders of magnitude the degree of the World System integration, which became integrated by powerful and constant currents of commodities, information, and services that stand in sharp contrast with previous discontinuous and fragmentary technological diffusion waves.

The World System became firmly integrated by the international division of labor. The second phase of the Industrial Revolution was indissolubly connected not only just with the growth of cities, but also with a radical growth of the degree of urbanization (that is the proportion of city-dwellers in the overall population), because during this period industries developed mostly within cities This situation was accompanied by (and in part a result of) the growth in the productivity of labor in agriculture (up to a very considerable degree due to the introduction of urban industrial products – various agricultural tools, machines, mineral fertilizers, pesticides and so on). This increase in the growth of the productivity of agricultural labor pushed the excess population into the cities where the representatives of this excess tended to find that it was possible to get jobs there just because of the impetuous growth of the urban industries and accompanying service sectors that demanded more and more working hands whom, however, the new economy managed to feed quite successfully precisely due to the growth of agricultural productivity. Naturally, on the one hand, such developments led to a vigorous increase in world urbanization that against the background of the hyperbolic growth of the world population led to an explosive, quadratic-hyperbolic growth of the world urban population (see Korotayev's article in the present issue of the Almanac), and explosive growth in the number of megacities and their sizes; on the other hand, these developments also contributed to the radical transformation of statehood and its phase transition to a new level in its development – to mature statehood. In its turn the transition from developed to mature statehood contributed to the amplification of the world urbanization processes.

The six stage of the World System development is connected with the information-scientific revolution of the second half of the 20th century (which corresponds to the second stage of Phase Transition A3); however, consideration of this period, as well as of **the seventh stage of the World System development** (corresponding to the epoch of the World System entering Attraction Basin A3) go beyond the scope of this article.

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Experiencing History Small: An analysis of political, economic and social change in a Sri Lankan Village

Victor C. de Munck

Descriptive statistical methods are frequently used to track social change at the community level. Thus even idiographic theories, those specific to a community or society, can be supplemented with the use of simple mathematical methods. It is likely that, despite the obvious problems in applying mathematical formulas to the analysis of individual beliefs and behaviors, in the near future the happenstance and improvisational quality of human behaviors will present a new opportunity and challenge for the mathematical modeling of micro-dynamic systems. The paper below does not represent an advance nor is it unique in its application of simple statistics, but it does suggest the need for applying more sophisticated mathematical models than those used in order to describe and analyze social change at the micro-level of the community. The statistical methods employed herein can only be used as snapshots by which we can compare static patterns, what is needed is to describe and understand the dynamics that related these cultural snapshots with one another.

This is a study of the process of diachronic cultural change at the local level and over a span of approximately 50 years. Ethnographic research was conducted in the Village of Kutali[1], located in the South-Eastern Uva Bintenne Province of Sri Lanka. During the main period of my research, between June 1979 and February 1982, the village was undergoing rapid, visible and explicit structural and cultural changes in its economic, political and social systems. By structural change I mean that "traditional" ascriptive and hereditary foundations of local political and economic structures were being replaced by achieved status based structures; by cultural change I mean that, coterminous with structural changes, changes in values and norms with regard to social relations were also manifestly changing.

Rural Sri Lankans live in what Daniel (1996: 175) calls a "land-centered" culture – in contrast to the "cash-centered" culture of the West, but as I shall empirically demonstrate these two systems were not in an oppositional but, rather complementary relationships with each other in Kutali village. My concern then is with significant changes as they occur *in situ* and over a relatively short period of time. As many chapters in this volume show, change in human life ways across the world is changing at an accelerating pace, so even a residence

[1] Kutali is a pseudonym I have used elsewhere.

of 3 years is enough to describe and anticipate significant changes at the micro-level. It is the challenge of macro-researchers to account for these micro-level changes in their dynamic macro-models of human history. History is written large, but experienced small.

In this study, I describe how three variables – the influx of cash into the local economy, government regulations, and population increase – have affected *chena* cultivation practices in Kutali. These three variables are intertwined like a Gordian knot. Though each is discussed, my primary focus will be to describe how the influx of money has affected labor practices and, more extensively, the cultural milieu of Kutali village. I begin with a brief description of the village of Kutali. Next, I present the "expected" or "traditional" model of *chena* cultivation practices.[2] Third, I describe recent adaptations to government regulations and population increases. Fourth, I will compare and describe the use of exchange and wage labor for preparing *chena* fields. I conclude with a discussion of the "disintegration" of kinship as a basis for perceiving and regulating social relations.

Kutali Village

Kutali Village is located in the Moneragala District just southeast of the mountainous vertebrae that runs north-south through the center of Sri Lanka. Along the western edge of Kutali lies the Nilgala forest which extends nearly to the eastern seaboard 60 miles away. In the other cardinal directions lay scattered hamlets of Sinhala Buddhist farmers. In 1982, the village population consisted of 1000 Muslims and 100 Sinhala Buddhists who lived on the outskirts of the village. Rain-fed rice paddy and *chena* (*i.e.,* shifting or swidden) cultivation are the mainstays of the local economy. *Chena* fields are situated in the less desirable and less fertile highlands away from water sources whereas paddy fields are located in the more fertile lowlands. Land holdings are small, with no family owning more than 15 acres of paddy land; the mean being 1.5 acres per family.[3] *Chena* fields are more uniform in size, with 90% of families cultivating between one and two acres.[4] Villagers considered rice their primary crop and *chena* crops (*i.e.*, finger millet and maize) of secondary importance. Livestock, hunting, timber, and the gathering of various forest resources for trade provided additional economic outlets.

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[2] Unfortunately, I do not have at my disposal these data for all the *chena* tracts.

[3] Acreage is a tricky business to estimate and I used villager's assessments which were based on the number of bushels of paddy they used to broadcast seeds across their fields, with four bushels approximating one acre.

[4] There are disputes over ownership to particular *chena* lands, most frequently between new Sinhala settlers to the area and Kutali Muslims. Because of the government movement towards regularizing lands through deeds, some people have lost their historical legitimacy to *chena* lands. Disputes over claims to *chena* lands are infrequent but highly volatile and will likely increase as official land titles replace historical claims to ownership.

The adult literacy rate of Kutali was 31% (119 of a sample of 384); with 65% (110/158) of the males and only 7% (9/126) of the females in the sample being literate. This compared poorly with national literacy averages of 86% for adult males and 71% for adult females. By Sri Lankan standards, the villagers are poor. Except for the three school teachers, only five adults were employed full-time: three as store clerks, one as a bus mechanic, and one as a driver.

Demographically, Kutali is an atypical village. 90% of the Moneragala District's population is Buddhist and 2% Muslim, compared to national averages of 67% and 7%, respectively. Kutali is the largest Muslim settlement in the district. Villagers are not only isolated from other Muslim populations, but feel threatened by a growing Sinhala population. Nearly all of the 100 Sinhala Buddhists living on the village periphery are post-1970 immigrants attracted by the availability of cheap arable land.

In a microcosmic sense, Kutali had an urban-like energy that was lacking in neighboring Sinhala communities. I suspect that this was due primarily to the Muslim heritage of trading which the adults (including women) took to with enthusiasm. Male villagers worked as seasonal laborers and traveled on business throughout the island; outsiders arrived daily to buy raw resources; Sinhala folk healers were called on to cure illnesses and local Sinhalese came by to chat or find work. Nevertheless, Kutali was a poor village: villagers walked barefooted and, in lieu of a flashlight, held a candle in half a coconut shell to reflect light when they walked about at night. Pandanus leaves were used as umbrellas, only six villagers owned bicycles, and there was no electricity or plumbing.

The villagers of Kutali, like other Sri Lankan villagers, farm both a rice paddy and a *chena* field. In an earlier publication, I referred to the *chena* and paddy cultivation periods as "seasonal cycles" with the *chena* season beginning in August and ending in November-December, just when the "paddy season" was starting up (de Munck 1993). I have also described a "festival season" that occurs in the lag between the rice harvest —May/April—and the beginning of the *chena* season. Each of these seasons has developed its own distinctive pattern of life; its own culture.

Chena culture: new and old strategies

Chena fields differ from rice paddy fields in a number of important ways. First, *chena* fields are located on highlands or other lands that are not near a water source, paddy fields are on lowland and near water sources. Second, villagers have leases or deeds for paddy fields, but usually do not have deeds for *chena* fields, which they lay claim to through historical rights. Third, *chena* lands are left untended for a number of years and revert to scrub lands (hence it is referred to as "shifting cultivation"), paddy fields are cultivated annually and used for grazing when fallow. Finally, except for the initial clearing of the scrub brush, most other tasks on a *chena* field are performed by women and children, who weed, guard and harvest the *chena* fields – in contrast to the paddy fields,

which are the domain of males. Maize (called "Indian corn" by villagers) and *kourakkan* (finger millet) are the two main *chena* crops; beans, manioc, sesame, and vegetables are grown as supplementary crops.

In 1981, only 8 of 203 Muslim households did not cultivate a *chena* field and all 33 Sinhala families farmed a *chena* field. A land survey I conducted with the help of A.A. Salaam, the local school principal, showed that there were approximately 700-800 acres of land potentially available for *chena* cultivation (including 224 acres that had been leased or deeded). Ideally, lands are rotated every three to five years to maximize yields. If we take the minimum estimate of 700 acres and the total of 203 households, then there was enough land for every family to rotate between three or four one-acre fields, the typical size of a *chena* field. However, of the 203 Muslim households, only 38 (18.7%) rotated between three fields, 124 (61.1%) rotated between two fields, and 41 (20.2%) households said that they did not rotate fields at all.

One reason for the disparity between the optimal and actual model of field rotation was that the village population had increased 43.4%, from 767 to 1100, between 1971 and 1981. Villagers worried that someone, possibly a new settler to the area, would claim an abandoned field for permanent occupation and the villager who previously cultivated that plot could do nothing about it. The government has also encouraged villagers to claim permanent *chena*s and abandon shifting cultivation practices, which erode soils and lead to the illegal clearing of forest lands.

To claim a permanent *chena* a person must either build a fence around the land or erect a durable dwelling on it. Next, permanent crops such as banana, coconut, lime and orange trees, or tubers, such as potato and manioc, should be planted. After staking a claim to a permanent *chena* field, the villager must obtain a letter of recommendation from the village head man (*grama sevaka*) or agricultural officer (*vel vidane*). The recommendation must then be approved by the Assistant Government Agent (A.G.A) or the District Revenue Officer (D.R.O.).

Historically, villagers adapted to local population increases by going further into the Nilgala forest and clearing land. In 1979, the Sri Lankan government passed a law prohibiting the clearing of jungle/forest lands without a permit. While this law remained ineffective in remote areas such as Kutali, it motivated villagers to apply for land deeds or long-term leases of government lands. In February 1981, the last land *kacheri* was held in Kutali. Previously, land *kacheri*s were held annually for the purpose of "regularizing" government lands. Villagers were allowed to claim two acres of lowland and one acre of highland and paid a nominal fee of two to five rupees for 99-year leases. The *kacheri* put some teeth into the 1979 law by confirming the government's position that no land could be cleared without first obtaining a permit.

Increased government regulations and the ability to enforce those regulations, in addition to population pressures, forced villagers to adopt new strategies for acquiring and cultivating *chena* lands. Many villagers cultivated both a

permanent and a shifting *chena* field and reduced the period of rotation from approximately 4 years to 2 years or less. Ultimately, the net effect of these adjustments was greater socio-economic differentiation, an increase in local conflicts and ethnic tensions, and the creation of a dependency relationship between villagers and government agents. Further, a family's risk of not meeting their subsistence needs increased by reducing the amount of land they could cultivate. Hence, these constraints reduced villagers' reliance on a land-centered economy and motivated them to seek employment and opportunities in the cash sector of the economy. While there was (between 1979 and 1982) no "flow" of villagers to the cities, most of the younger adults worked as temporary laborers in nearby towns.

Selecting a *chena* field

Selection of a *chena* field is as much a group decision as an individual one. One man explained that, "The clearing of a *chena* field must be done at about the same time by everyone for protection from wild animals and thieves. If you only have one solitary *chena* field, then you must keep an eye on it at all times. Not only will people know when the field is not being watched, but all of the wild animals in the area will concentrate on that field."

Typically, a *chena* tract consists of ten to twenty *chena* fields, ranging from one to two acres in area. Tracts are always bounded by a makeshift but sturdy wooden fence. *Chena* tracts demarcate a social as well as an agricultural space, with the members of the households expected to work together and coordinate their activities. For example, one typical tract of 18 *chena* fields consisted of 19 households connected through either a sibling or parent-child link (see Table 1).

Table 1 reflects the predominance of kinship as a criterion for selecting *chena* fields and as a basis for cooperation. Table 1 also further substantiates Obeyesekere's (1967:75) assertion that the idiom of Sri Lankan kinship is used to express (and I would add, organize) property relations. A land-centered culture is, in this instance, also a kin-centered culture with land and kinship networks woven together by the exigencies of work without capital.

Table 1. Relations among Households Cultivating *Chena* Fields in One Tract

PA-CHILD		SIBLING			DISTANT KIN
Pa–Da	*Pa–So*	*Bro–Si*	*Bro–Bro*	*Si–Si*	
3	3	7	3	0	3

Recruiting labor for *chena* work

Malleyar ("Mountain-man") offered me a vivid portrayal of the problems and tasks that go with farming a *chena* field. He said,

If you begin too early, before the rains, then the seeds will die or you will get weeds and will have to turn them up again, doubling the work. If you wait too long, you can't burn the vegetation; you will have to wait for a period of sunshine. After burning, you weed and then sow the seeds. For Indian corn, you have to dig small holes, eight inches apart and put two seeds in each hole. If one seed is bad, the other will germinate. Sometimes the holes may be attacked by white ants. If the plant is healthy, it will grow six to eight feet in height. On one acre you can plant about five hundred Indian corn seeds, which may give you a harvest of thirty to forty bushels. Between the corn you broadcast *kourakkan* and cover the seeds lightly. *Kourakkan* grows up to two and a half feet. With an exceptional crop you may harvest 100 bushels. If the ground is bad, the yield will be badly affected. Neither corn nor *kourakkan* requires much water, and no manure or insecticide is used. Once that is over, you can broadcast some gingelly (sesame seed) which grows to three feet, and for one acre you can harvest forty to fifty bushels.

There are two ways to recruit labor for these tasks: *atam waede* (reciprocal labor exchange) and daily wage labor. For *atam waede*, a person will recruit a number of people to help work a *chena* field. In return, that person will work on each of those people's fields approximately an equivalent amount of time. Significantly, *atam waede* does not involve cash and the relations are usually long term, rolling over from task to task, year to year, and from *chena* to paddy cultivation. Regardless of labor type used, laborers have to be provided with tea, betel chew and lunch. The table below provides a summary description of the acreage, variety of crops, and forms of labor used on one *chena* tract containing twenty-eight fields.

Table 2. Acreage, Type of Labor, and Variety of Crops Sown on *Chena* Lands

Field #	*Acreage*	*Atam waede*	*Wage Labor*	*Variety of Crops*
1	2	yes	yes	Indian corn (IC), *kourakkan* (K), manioc (M)
2	2	yes	yes	IC, K, cow peas, coconut
3	1	yes	no	IC, K, M, banana
4	3	yes	no	IC, K, long bean, banana
5	1	?	?	IC, K, cow pea

Field #	*Acreage*	*Atam waede*	*Wage Labor*	*Variety of Crops*
6	2	yes	no	IC, K
7	1	?	?	IC, cow pea, long bean
8	1.5	yes	no	IC, cow peas
9	1	yes	no	IC, K
10	1	yes	no	IC, K
11	.5	?	?	IC, K
12	1.5	no	yes	IC, K, pumpkin, cucumber
13	2	yes	yes	IC, K long bean, cow pea
14	1.5	yes	no	IC, K, M, long bean, cow pea
15	1	yes	no	IC, K, M
16	1.5	yes	no	IC, K, M, cow pea, long bean
17	.75	yes	no	IC, K, cow pea, long bean
18	1.5	yes	no	IC, K, M, pumpkin, cucumber
19	1.5	no	yes	IC, K, pumpkin, cucumber, banana, paddy
20	1	no*	no	IC, K *did all the work on his own.
21	1	yes	no	IC, K, long bean, paddy
22	2	yes	no	IC, K, sesame, cow pea
23	2	yes	no	IC, K, pumpkin
24	1.5	yes	no	IC, sesame
25	2	yes	no	IC, K, sugar cane
26	1	no	yes	IC, K, cucumber, sesame
27	1	yes	yes	IC, K, long beans
28	1	?	?	IC, K
	avg=1.42	*y*=20; *n*=4	*y*=7, *n*=17	

These crops are divided in to crops used for domestic consumption–Indian corn (or maize), *kourakkan*, beans, peas, and a few crops which are sold at market–

sugar cane, sesame, banana and sometimes coconut. Clearly *chena* cultivation is primarily used for domestic, that is traditional, consumption.

In terms of recruiting labor, of the twenty-four families that I have data for, sixteen (66.7%) relied exclusively on *atam waede*, four (16.7%) on a mixture of *atam waede* and wage labor, and three (12.5%) used exclusively wage labor (one person worked the *chena* field alone).

Table 3. Comparing Modes of Recruiting Labor

		WAGE LABOR	
		yes	**no**
ATAM LABOR	**yes**	4	16
	no	3	1

Unfortunately, I did not systematically inquire into the relations between field owners and laborers as it was taken for granted that all *atam waede* relations were between kin. On the other hand all wage labor was between non or distant kin. It was unlikely, indeed improbable, that individuals would actually hire their close relatives for *chena* work, that would be both unnecessary and an insult. Clearly, the prevalence of *atam waede* demonstrates that the local culture was centered around land and kinship. However, the use of capital provides a viable alternative route for recruiting labor as evidenced by the seven (29.2%) families who used wage labor.

The socio-cultural implications of the difference between these two recruiting policies are significant. Wage labor offers a contractual definition of the relationship between an employer and employees. In the case of wage labor, the rate of pay for a particular amount of work is precisely specified, whereas in *atam waede* the exchange of labor for labor is always approximated. For example, the minimum wage in the U.S. specifies that a minimum wage laborer earns precisely $5.15 per hour, not a penny more or less. But if you help your friend move and later he helps you move, the exchange is considered roughly, and appropriately, equivalent. However, the formula for converting the value of labor into a cash value is necessarily arbitrary, as both measures of value are independent of one another. Consequently, wage labor and reciprocal labor exchange systems are inversely related in terms of what is approximated and what is precisely measured. With wages, the conversion of values is approximate but, once determined, it is measured precisely as is the duration of the relationship, which terminates upon completion of the work or amount of hours hired. With labor exchange, the value is precise (work for work) but the measure is approximate and the relationship stretches both backward in time (as an established relationship) and forward in time (to be activated the next *chena* season).

Once the value of cash to labor is established, favoring those land owners with surplus capital to spend on wage labor, then the benefits of a land/kin-

centered culture become dubious and, often, avalanched by its attendant costs. People no longer just fight with or cooperate with particular kin, but begin to question the whole enterprise of kinship.

Even though only a minority of villagers hire labor, one can see that, even for crops that are used for domestic consumption and not for profit, many villagers have begun to practice wage labor rather than the traditional reciprocal labor exchange system.

In the political structure of Kutali we also see an erosion of the traditional power structure which is based on hereditary, ascriptive status in which the leaders of the mosque were also the political leaders and members of the wealthy families in the village. This sort of condensation of power no longer holds completely.

The structure of leadership

Mahroof (1979) wrote that at the turn of the 19th century, Muslim village leadership was entrusted to mosque administrators called *marikar*s; the head *marikar* was given the title trustee. Though nominally an elective post, in practice it tends to devolve through descent. For example, the current trustee, Hassan, replaced his elder brother, Mohideen, who had succeeded his elder sister's husband, Adam Marikar, who succeeded the father of Hassan and Mohideen. The primary function of *marikar*s is to administrate mosque activities and religious celebrations. *Marikar*s mediate in the various stages of the marriage selection process, particularly dowry negotiations; they are also called on to resolve conflicts involving pre- or extra-marital relations. *Marikar*s, as well as other religious personages, served (and in Kutali still serve) as the socio-moral guardians and leaders of the village.[5]

From my perspective, there were definite village leaders who I recognized through the exercise of political rather than religious roles. Those who I reckoned as leaders held political offices, acted as village spokesman when government representatives visited, and, most importantly, demonstrated the capacity to obtain and manipulate government and national level resources and agencies. From this perspective, Pitchai and Mohideen were the most visible and powerful local level leaders. Mohideen was the Village Council representative and had been the mosque trustee. Mohideen was one of the three largest landowning villagers with approximately 15 acres of paddy land; he owned the longest-running and probably most successful village store; and through his wife, he loaned money to villagers. But a large source of Mohideen's income and clout came from his capacity to obtain contracts for government sponsored development projects. Pitchai had also become a wealthy man. Though he

[5] The role of moral guardianship was increasingly devolving to more religiously trained statuses such as Maulevis, who had received instruction in Islam and Arabic. None of the *marikar*s had received such training.

owned far less land than Mohideen, Pitchai owned a village store, and earned much of his income by buying local foodstuffs and goods and selling them to large merchants at nearby fairs. Mohideen and Pitchai were also the respective leaders of the two rural cooperative societies through which funds were channeled for local development projects.

Pitchai and Mohideen were the official village representatives for the United National Party (UNP), the political party in power at the time. When politicians or government officials came to Kutali it was usually Pitchai who hosted them and acted as the village spokesman. Pitchai and Mohideen competed with one another for political resources, but they could cooperate against a common foe. For example, when the *Grama Sevaka*, the government appointed administrator for the village, had confiscated timber valued at 10,000 rupees from Mohideen, Mohideen and Pitchai had joined forces and visited the region's UNP Member of Parliament (MP) in Colombo to petition for the return of the timber. Their petition was successful--the timber was returned and the Grama Sevaka was shortly thereafter transferred. Pitchai and Mohideen fit the classical ethnographic descriptions of political middlemen or gatekeepers who bridge and manipulate both local and national level political structures. For these reason, I took them to be the village leaders.

To discover the villagers' perceptions of the local level leadership structure, I asked 42 adult male villagers to name 5 village leaders and to discuss their selections.[7] For the sake of brevity, Table 4 presents only the 9 most frequently named individuals and the leadership qualities attributed to them. The categories of leadership attributes were derived from the villagers' responses.

Table 4. Village Leaders and their Attributes

Name	Freq. Cited	K	R	P	W	HV	H M	GC	SD
1. Adam *Marikar*	25	10	25	1	0	8	2	3	14
2. H. Trustee	21	10	21	0	0	10	0	3	3
3. Pitchai	19	13	3	7	9	10	7	3	2
4. Mohideen	18	13	7	15	6	5	5	1	2
5. Yassim	14	8	12	0	10	5	7	6	0
6. W. Mahatteya	13	9	12	0	0	12	1	1	0
7. Koostapel	11	9	1	3	2	2	1	1	1
8. Lebbe	9	9	9	0	0	3	2	4	0
9. Hamsa	7	5	7	0	0	4	4	3	1

KEY: K=kinship; R=Religiosity; P=politics; W=wealth; HV=helps village; HM=helps me; GC=good character; SD=settles disputes.

The four individuals most frequently cited as village leaders represent a conjunction of Mahroof's analysis of traditional Muslim villages and my own ob-

servations. Adam *Marikar* is the retired Mosque trustee and the "uncle" (*maama*) of Hassan and Mohideen. Note, in passing, that Adam was the only leader cited for resolving disputes; this, I think, is due partly to his reputation as trustee "emeritus" and to the increasing effectiveness of outside agencies to adjudicate local conflicts.

On the basis of attribute frequencies, the top four leaders (Adam, Hassan, Pitchai, and Mohideen) neatly represent two distinct forms of leadership. Religious reasons were most frequently cited for selecting Adam and Hassan and political clout and wealth were most frequently cited as reasons for selecting Pitchai and Mohideen. Mohideen also received religious citations, due to his previous position as trustee and his genealogical connections with the position. Except for Mohideen receiving some religious cites, due to his connection with the post, the criteria used to attribute leadership were bifurcated with little dispersion across leaders. This implies a dual conception of leadership at the community level, with one kind of leadership form linked to the religious realm and the other to political-economic realm of village life.[6]

Table 5. Frequency Sums for Leadership Attributes.

K	R	P	W	HV	HM	GC	SD
86	97	26	27	59	29	25	23

Table 5 presents the cumulative count each criterion was cited by the 42 informants. Kinship was one of the most frequently cited attributes and the top four leaders were also the four receiving the most kinship cites. Kinship, that is, village ancestry, remains a minimal and necessary condition for attaining positions of local leadership. Cumulatively, Adam and Hassan received 47.4% (46/97) of all religious citations, while Pitchai and Mohideen cumulatively received 55.6% (15/27) of the citations for wealth and 84.6% (22/26) citations for political clout. The low number of citations for political clout (26) is roughly similar to the frequency of citations for "settles disputes" and conforms with my earlier observation that funds of political power have been transferred to governmental departments. The cumulative score for political clout also indicates that Pitchai and Mohideen monopolize links and access to governmental funds of power.

Adam and Hassan represent a Muslim socio-religious identity through which reputation and honor are claimed through adherence to Islamic codes of behavior, beliefs and values. They symbolize the Islamic code of unity, of self-similarity, as expressed in the concept of *Umma* – the community of believers. In lives that accommodate the mosque and the market Adam and Hassan lead by example, balancing prayer and labor. Control efforts are directed towards uniformity in behavior and exacted on those who breach Islamic norms. Sanctions are usually collectively implemented. For example, the parents of an unmarried woman with a one year-old child had petitioned the mosque to force

the father, who had recently found a gem which he had sold for 10,000 rupees, to marry their daughter even though he had been voluntarily paying child support. The man had used his new-found wealth to open a small shop and had agreed to the marriage stating that if he refused no one would shop at his store.

Control efforts are derived from and enforced by a socio-religious habitus, repertoires of social action that is consciously recognized only when it is neglected by some individual. The degree of control co-varies with the spread, or dispersion, of the particular socio-religious habitus. Thus, the fewer people are disposed to a said habitus the less effective the control efforts. The mosque, located in the center of the village, is the metaphorical site of power and identity. Its centripetal pull is manifest through its "role" as the place where all important family and collective events and rituals are ultimately validated and that those who pull out of its orbit are punished or ostracized. Adam and Hassan are the "trustees" of that role and, in that sense, also represent the personification of a social form.

Pitchai's and Mohideen's claim to leadership is instrumental in that it is grounded in their respective abilities to substantially affect the political and economic fortunes of members of the community. They represent an entrepreneurial identity, one that moves confidently and competently in the world beyond the village boundaries. They occupy a connective kind of social formation because for politicians their power is derived from their capacity to control local voting blocs, while for villagers their power is derived from their capacity to control politicians. Pitchai and Mohideen link disparate social units together into a social formation where the character and actions of identities are substantively different. The principle of self-similarity is reduced to the articulation of complementary resources, as in the case of buyers and sellers. A social formation emerges that negates the individual as the unit of identity and substitutes the '(weak) tie-as resource-conduit' as the salient unit of identity. Identities inhere not in the people themselves but in the coupling and uncoupling of matching interests. Pitchai and Mohideen represent a very different type of social formation, and power structure, then Adam and Hassan. For the latter it is important that they look like, act like, inhabit the same places, and share broadly similar perceptions as their "clients." Their power is constituted out of their mirror-like reflection of the community; it is narcissistic.

Pitchai and Mohideen represent a social formation where control efforts are based on the relative capacities of ties to channel resources. Interactions generate a long tendril of complementary ties (like the tail of a kite) so that villagers are linked, as clients, to Pitchai and Mohideen who, as political middlemen, are linked to politicians (the MP) who, in turn, are gatekeepers to government resources. The links match because each node knots together different resources wanted by the adjacent node. It is the connection that establishes the value of the node, not the node itself. Villagers provide the popular support Pitchai needs to attract the MP who offers Pitchai resources necessary for Pitchai to attract a following. As people become embedded or coupled to this particular so-

cial formation, the redundancy of actions precipitate a menu of stories that institutionalize these actions in terms of motives, goals, scripts for behavior, values, and statuses (Schank and Abelson 1977; D'Andrade 1987; Schank 1998; White 1992). Pitchai and Mohideen's power emanates from the structural linkage between community and national structures. Their connection to the community is genealogically and spatially prescribed, their connection to the outside world is opportunistically prescribed and made possible by the growth and interpenetration of national social forms. The idiom of kinship provides the core vocabulary for the menu of stories that I now turn to.

The idiom of kinship

Language is a socially shared system of signs that communicates by mapping personal linguistic strings onto public linguistic strings through transformational rules. As Obeyesekere (1967:10), among others, noted Sri Lankans use kinship to express property relations. Similarly, we have seen how the organization and use of *chena* lands, the recruitment of labor, and the structure of village leadership are expressed in the idiom of kinship.

White (1992), White and Houseman (1993) and Kronenfeld (1973), among others, have shown that we must be careful, for it is not kinship, per se, that orders social space. Rather kinship networks, as graphically represented, are the structural embodiment of historically iterative and patterned actions that are, then, transcribed and communicated through the idiom of kinship. For example, during weddings and other village ceremonies, villagers gleefully shout out "we are one." The spatial, behavioral and ideological congealing of villagers during social rituals nucleates their identity in Durkheimian fashion. The idiom of kinship is used to express village social solidarity, expectations for cooperation, support and identity and reflects the strong ties that bind the village into the meta-structural equivalence of family.

The idiom of kinship blankets everyone under the cloak of self-similarity and mutual obligations, weaving a dense web that both supports and, from another perspective, imprisons. A villager crystallizes his own ambivalence towards kin as follows:

All people are faced with this problem: let's say the father or elder brother went out of the village on business or to work a job. When he comes home on vacation he will have to bring home all sorts of gifts and eatables. As soon as he steps off the bus, people will crowd around him and all the children will demand candies. He will have to give them all something otherwise the parents of the children will find out and gossip about his spendthrift ways, this will cause uneasiness among all relations. When he steps off the bus he will end up completely embarrassed because there is no way to satisfy everyone. He will have to buy presents for his wife and children, and also for his sisters and his wife's sisters.

His brothers and cousins will think he is rich and ask for loans. Instead of cooking one measure of rice for meals, his wife will have to cook two or three measures, just to feed the people who will come by for meals. Relations will come by to borrow something from him and he will have to give it to them, otherwise they will be offended and all sorts of trouble will start.

The source of tension in this account is the consideration of the accumulation of money and goods obtained from outside the community. Explicit is the theme that actions, particularly entrepreneurial activities that occur outside the village serve to differentiate that villager from other villagers on his return. The actions taken by the villagers have the consequence (if successful) of restoring the returnee to social equilibrium as that which materially differentiates him from other villagers is redistributed among the villagers. The principle of self similarity is asserted to efface social differentiation. Kinship provides the story lines that legitimate the villagers' requests and compel the returnee to comply.

Within the village, the temporal re-occurrence of the same repertoires of actions embedded in social contexts and triggered by the same stimuli (such as the start of the rainy season triggers that repertoire of actions associated with *chena* cultivation) are reified and given expression in the idiom of kinship. Kinship ideology and belief systems such as the evil or envious eye symbolically de-differentiate individuals by providing menus of stories that portray the unfortunate consequences of differentiation. Ecological and cultural triggering mechanisms (e.g. drought, disease, marriage, birth, death) set repertoires of self-similar actions into motion across the village. So long as the village has an identifiable structure and identity, the villagers work to maintain that structure and identity. Difference pollutes and can infect the whole, fragmenting it.

As individuals exit the village and involve themselves in commerce and intercourse with non-kin, the villagers' impositions of kinship are no longer valued positively, rather kinship ties are construed as deterrents to success. As the frequencies of actions in arenas other than the village increase and the shared repertoire of actions and common behavioral/cognitive triggers decrease, so the scope and stories of kinship as the "diffusion of affinity" (Gluckman 1956) diminish though terminologically the kinship system remains unchanged. The alternative, of course, is to re-invent the scope of kinship, through cognitive simplification, to subsume ever dispersed and larger groups (e.g. the nation and ethnic groups) under the rubric of kinship.

Kinship divides in two ways: one, when we contest the propriety of behavior, second, when we contest the privilege of kinship. In the first we have disputes between kin, with one or both parties claiming that the other is not behaving "like a brother should." This leads to what Beals and Siegel (1966) call "normative disputes" and does not threaten the structure itself. The second, leads to questions about the structure and power of kinship as being privileged over other social forms and identities. Such conflicts lead (or may lead) to a radical change in social forms and identities where the older (*i.e.* kin) forms of

power and control are no longer deemed legitimate because they have been replaced and/or attenuated by other forms of power, identity and control.

Conclusion

History is often written at the macro-level and consists of general global temporal processes that do not seem to bear any relevance on the local present. Yet here we see at least one global macro process—that of the penetration of global market forces, capital, and national supra-communal political structures into the local realm of a Sri Lankan village. The focus in this chapter is to show how villagers adapt to these changes. They do not necessarily evaluate changes in terms of their effects on traditional structures but as forces; some villagers see these new forces as providing opportunities others as constraints. In this chapter I show how economic and political adaptations have led to a questioning of the cultural value of an idiom of kinship which has not just been the basis by which villagers interact with others and see their standing in the world, but has also served as the socio-moral mooring by which they judge and guide their own actions as well as those of others. The new world that they have entered is one that is accelerating in its momentum away from traditional structures that hold and orient villagers in the world. as Leonid Grinin notes (this volume), the price that we have to pay to adjust to these developmental vectors which have a supra human momentum, should not just be measured in environmental or demographic but also cultural costs.

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Modeling (and Measuring) Expansionism and Resistance: State formation in Ancient Oaxaca, Mexico

Charles S. Spencer

One of the earliest examples of state formation in ancient Mesoamerica was the early Zapotec state, whose capital was Monte Albán, located on a hill-top in the center of Mexico's Valley of Oaxaca (Blanton 1978; Marcus and Flannery 1996) (Fig. 1).

During the Rosario phase (700–500 B.C.), the Oaxaca Valley was occupied by three chiefly polities, one in each of the three major branches of the Valley that radiate out from the center (Etla, Tlacolula, and Ocotlán-Zimatlán). Monte Albán was founded in the Early Monte Albán I (Early MA I) phase (500–300 B.C.), probably by people from the Rosario-phase capital of San José Mogote in Etla (Marcus and Flannery 1996: 139–140). Yet, state institutions did not appear in Oaxaca until the Late Monte Albán I (Late MA I) phase (300–100 B.C.) (Spencer 2003; Spencer and Redmond 2004a, 2004b). Late MA I is also the first phase for which there is convincing evidence that Monte Albán expanded its territory through military conquest (Spencer and Redmond 2004a); before Late MA I, Monte Albán's militarism evidently consisted primarily of raiding activities (Redmond and Spencer 2006). The process of territorial expansion that began around 300 B.C. was markedly asymmetric (Redmond and Spencer 2006; Spencer n.d.; Spencer and Redmond 2001a, 2003, 2005, 2006). Rather than growing concentrically, Monte Albán appears to have expanded its territory first to the north, west, and southwest during Late MA I, incorporating such distant regions as the Cañada de Cuicatlán (some 80 km north of the capital) (Spencer and Redmond 2001b) and the Sola Valley (75 km southwest of the capital) (Balkansky 2002). It was not until the Monte Albán II (MA II) phase (100 B.C. – A.D. 200) that Monte Albán managed to annex two much-closer polities in the Ocotlán-Zimatlán and Tlacolula subvalleys, whose capitals lay only 20–25 km from Monte Albán to the south and east, respectively (Spencer and Redmond 2005).

Drawing upon our excavations and survey at San Martín Tilcajete, the capital of the Ocotlán-Zimatlán polity, we have proposed that various strategies of resistance were successfully pursued by that polity (and, we would hypothesize, the Tlacolula polity, whose capital was at Yegüih), throughout Early MA I and Late MA I (Spencer and Redmond 2003, 2006).

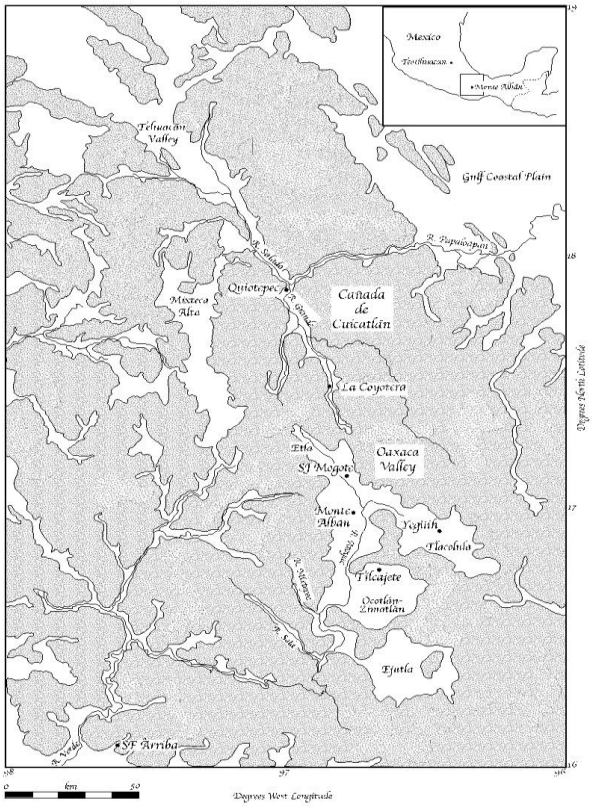

Figure 1. The Valley of Oaxaca and major subvalleys, including Etla, Ocotlán-Zimatlán, and Tlacolula, along with a number of surrounding regions; major archaeological sites are also indicated.

These resistance strategies included population nucleation, more centralized political organization, a shift (between Early MA I and Late MA I) in the location of the main plaza to a more defensible location, the construction of fortifications, the expression of local autonomy through architectural and ceramic styles that differed from those at Monte Albán, and the development of secondary

state organization during Late MA I (Spencer and Redmond 2006). In the early years of MA II, Monte Albán overcame these resistance strategies and succeeded in incorporating the Ocotlán-Zimatlán and Tlacolula subvalleys into the larger state organization.

The resistance exhibited by Ocotlán-Zimatlán and Tlacolula can be understood not only as a reaction to the expansionism of Monte Albán, but also as a dynamic ingredient in the process of state formation (Spencer and Redmond 2006). When the Ocotlán-Zimatlán and Tlacolula polities withstood Monte Albán's efforts to subjugate them at the onset of Late MA I, they effectively compelled Monte Albán to direct its military activities at other, more distant, territories such as the Cañada and Sola. The long-term subjugation of these distant territories required important organizational changes by Monte Albán, including the development of a full-time military and an internally-specialized administration that was capable of delegating partial authority to functionaries who oversaw the management of conquered lands. These organizational changes were central to the process of primary state formation in Oaxaca.

It is reasonable to ask why it took so long for Monte Albán to subjugate the rival polities of Yegüih and Tilcajete. After all, Monte Albán dominated the Etla and Central areas in both Early MA I and Late MA I, and during both phases controlled a much larger population than Yegüih or Tilcajete. Is it credible that the resistance strategies pursued by the latter two polities could have withstood the raiding and subsequent conquest strategies of Monte Albán for a period of four centuries? I will approach this problem by developing a dynamic model of expansion and resistance, and then applying this model to diachronic data from the Etla-Central, Tlacolula, and Ocotlán-Zimatlán subvalleys of Oaxaca.

Modeling expansionism and resistance

Mathematics can potentially contribute to the study of human history in two fundamental ways: (1) the mathematical modeling of historical processes and (2) the quantitative analysis of historic (or prehistoric) data. Rashevsky (1968) developed a series of theoretical models (mostly based on differential equations) that sought to model patterns of interaction among individuals and social groups, including such phenomena as the spread of mass imitative behavior, coercive recruitment, and rapid revolutionary change. More recently, Turchin (2003) not only constructed mathematical models of the growth and decline of ancient states, but also used quantitative analysis to evaluate these models against the historical record.

Although Rashevsky (1968) did not apply his models to empirical data, I think certain aspects of his discussion are relevant to the Oaxaca case, in particular the role played by resistance in the rise of the Monte Albán state. In this section, I will attempt to construct a simple dynamic model that encompasses both expansionism and resistance; later on, I will seek to assess this model

through an analysis of quantitative data gleaned from the archaeological record of Oaxaca.

As is always the case with modeling exercises, we begin with some simplifying assumptions, following the discussion in Rashevsky (1968: 35–37). First, let us assume that we have a total population of N_0 individuals (which we might conceptualize as the total population of the Valley of Oaxaca, including the Etla-Central, Ocotlán-Zimatlán, and Tlacolula subvalleys), a subset of which (N) is not part of one or more elite leadership structures and thus available for recruitment. We will also assume that the leadership of a growing polity (*e.g.*, Monte Albán) is aggressively seeking to recruit or annex the entire population of N (non-elite) individuals. Let us further assume that all N individuals can exhibit one of two mutually exclusive behaviors: R_1 *vs.* R_2. Let us say that R_1 represents recruitment or joining behavior, while R_2 behavior represents resistance to recruitment or annexation by the aggressor polity. Let us also assume that the there is a tendency $\varphi = \varepsilon_1 - \varepsilon_2$ toward R_1 or R_2 that is distributed according to a symmetrical function $f(\varphi)$. In our Oaxaca case, during the Early MA I and Late MA I phases, R_1 represents membership in the Monte Albán polity, while R_2 behavior represents membership in the resistant sector, which would include the Ocotlán-Zimatlán and Tlacolula polities.

Now, along with the N (non-elite) individuals, let there be X_0 individuals who both display behavior R_1 and also try to coerce or induce the "influenceable" (i.e., N) individuals to display behavior R_1. Let there also be Y_0 individuals who display only behavior R_2 and who try to coerce or induce the N "influenceable" individuals to display R_2. We assume that the X_0 and Y_0 individuals are "uninfluenceable" because they represent the elite sectors of separate polities. In our Oaxaca case, X_0 would represent the Monte Albán elite, while Y_0 would represent the elite sectors in the resistant subvalleys of Ocotlán-Zimatlán and Tlacolula. The N "influenceable" individuals are characterized by the distribution $f(\varphi)$ and are subject to influence by the X_0 or Y_0 sectors. The total population can be expressed as follows: $N_0 = N + X_0 + Y_0$ (Rashevsky 1968:35). The equation implies a trimodal overall distribution, with individuals belonging to the group X_0 having a very high positive φ, and the individuals belonging to the group Y_0 having a very large negative φ. The "influenceable" N individuals are far more numerous and are distributed according to the function $f(\varphi)$. The overall trimodal function can be called $f_1(\varphi)$. When X_0 and Y_0 exert equivalent influences on N, the distribution function $f(\varphi)$ is symmetrical around $\varphi = 0$. Given that $N = X + Y$, any displacement of the overall distribution function to the right or the left results in a change in X and Y, the number of influenceable individuals who exhibit R_1 and R_2, respectively. This displacement would not affect X_0 or Y_0 unless it involves a virtually complete shift to either R_1 or R_2 by the influenceable individuals, leaving the elite on the losing side without any followers. As Rashevsky (1968:36) points out, whether an N (influenceable) individual is influenced by coercion or persuasion, the outcome is the same: in the case of R_1, the effect of the influence would be an increment of ε_1 by an

amount of $\varepsilon_{1'}$; in the case of R_2, the effect of the influence would be an increment of ε_2 by an amount $\varepsilon_{2'}$. So, we can view the influence exerted by the X_0 individuals as the stimulus that yields an increase in ε_1, and the countervailing influence by the Y_0 individuals is the stimulus that increases ε_2. We shall also posit that the intensity of the stimulus that increases ε_1 will be proportional to X_0, and also proportional to a factor A_1 that represents the means of coercion or persuasion available to the X_0 individuals. Following Rashevsky (1968: Equation 4.2), we can write the following equation for the effect of the stimulus exerted by the X_0 group:

(1) $d\varepsilon_{1'}/dt = A_1X_0 - a\varepsilon_{1'}$.

This equation is adapted from Rashevsky's basic equations of the central nervous system (Rashevsky 1960, 1961, 1964); the $a\varepsilon_{1'}$ term represents the effects of stimuli that are lost through inefficiency (ultimately, to entropy). In similar fashion, we can write the following equation for the effect of the stimulus exerted by the Y_0 group, in line with Rashevsky (1968:Equation 4.3):

(2) $d\varepsilon_{2'}/dt = A_2Y_0 - a\varepsilon_{2'}$.

Now, because $\varphi = \varepsilon_{1'} - \varepsilon_{2'}$, we combine the equations (Rashevsky 1968:Equation 4.4) to yield:

(3) $d\varphi/dt = A_1X_0 - A_2Y_0 - a\varphi$.

This equation is meant to express the rate of change in the effects of the influence directed by X_0 toward the N (influenceable) individuals; it is a way of characterizing the process of coercive recruitment by the X_0 polity.

Of course, mathematical models are inevitably simplistic; real-life situations are complicated. For example, it seems clear that both X_0 and Y_0 will be subject to change over time. Similarly, the effectiveness of their respective coercive mechanisms A_1 and A_2, might also be expected vary over time, due to such factors as differences in the leadership ability of individual leaders and changes in coercive technologies. Also, the model presents the expansionistic vs. resistant polities as a closed system, whereas most real-life polities do not exist in isolation but are surrounded by numerous other polities. Such caveats notwithstanding, I suggest that mathematical model in Equation (3) does shed some heuristic light, primarily because it directs our attention to *the rate of change* in the process of recruitment. In particular, the model implies that the effectiveness of coercive influence is positively related not simply to the amount of gross membership in the expanding (X_0) polity, but rather to the rate of change in the effects of that influence, which is a function of the coercive mechanisms and leadership of not only the expanding polity but also the resisting group. Thus, the model is both dynamic and interactive, with key roles assigned to both domination and resistance.

Measuring resistance

Our program of archaeological research at San Martín Tilcajete began in 1993 and consisted of intensive survey and excavation at a cluster of three archaeo-

logical sites: El Mogote (SMT-11a), El Palenque (SMT-11b), and Los Mogotes or Cerro Tilcajete (SMT-23) (Fig. 2):

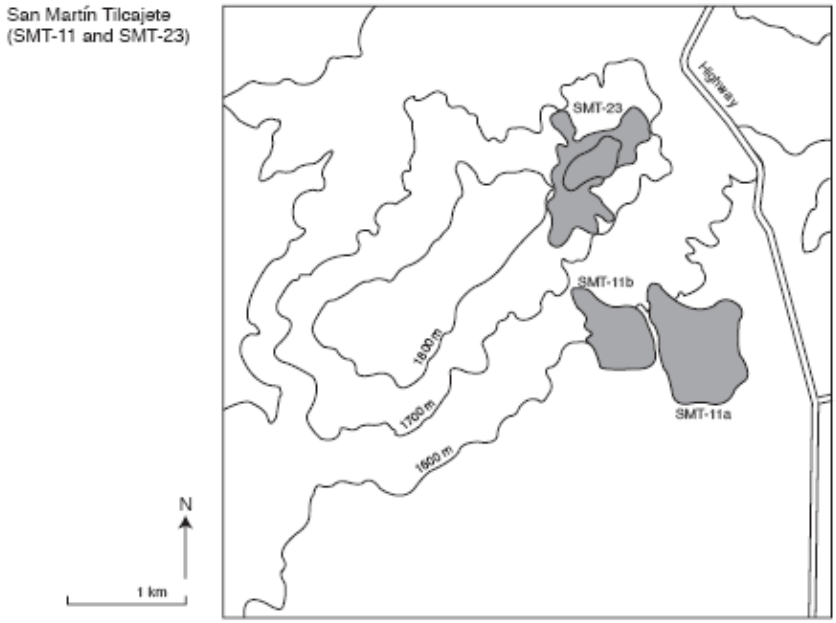

Figure 2. The Tilcajete localitiy, showing the archaeological sites El Mogote (SMT-11a), El Palenque (SMT-11b), and Los Mogotes or Cerro Tilcajete (SMT-23); these sites are situated about 2 km north of the modern town of San Martín Tilcajete, Ocotlán, Oaxaca.

The phases of occupation at these sites that were of most interest to us were Rosario, Early MA I, Late MA I, and MA II. The sites were located in 1978 by the Oaxaca Settlement Pattern Project (Blanton et al. 1982). Charles Spencer and Elsa Redmond directed mapping and surface collecting at all three sites in 1993-94, followed by excavations at El Mogote and El Palenque in 1995-2000. Christina Elson directed excavations at Los Mogotes (Cerro Tilcajete) in 1999-2001 (Elson 2003).

Our work at Tilcajete was designed to be comprehensive, aimed at collecting information about the demographic, economic, social, political, and religious aspects of these communities. In doing so, we were guided by two fundamental research questions: (1) when did key state institutions (such as the palace and the multi-room temple) appear in the sequence; and (2) when was the San Martín Tilcajete area integrated into the Monte Albán polity? As we have noted in a number of previous papers, state institutions first appeared at Tilcajete in Late MA I, but the Tilcajete area was not annexed by Monte Albán

until MA II (Spencer and Redmond 2001a, 2003, 2005, 2006). We have suggested that the Late MA I occupation at Tilcajete, which was focused on the El Palenque site, was the capital of a secondary state during Late MA I. We have also argued that secondary state formation here was one of several strategies of resistance that the Tilcajete people pursued to protect themselves against Monte Albán's expansionistic actions.

The El Mogote site has a long occupation: it covered some 6.5 ha during the San José phase (1150–850 B.C.), growing to 25 ha during the Rosario phase. Marcus and Flannery (1996: 123–124) have suggested that the Rosario phase chiefdom in the Etla subvalley often had hostile relations with the other two subvalleys; the relatively unoccupied Central area, they have suggested, might have been a buffer zone that developed between the Etla chiefdom and its neighbors to the east and south. Independent evidence of violence during this phase includes the relatively high frequencies of burnt daub on Rosario phase sites (probably a consequence of raiding activities), a burned Rosario phase temple at San José Mogote, and a carved stone (Monument 3) that depicts a sacrificed captive (Marcus and Flannery 1996: 128–129).

El Mogote grew to cover 52.8 ha in the Early MA I phase, when a 2-ha main plaza was built at the site (Fig. 3):

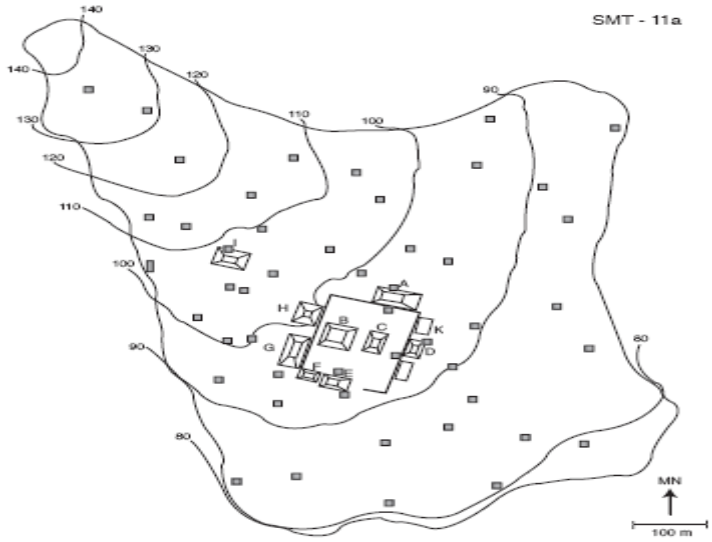

Figure 3. Schematic plan of the El Mogote site (SMT-11a), showing the plaza, major mounds, and locations of intensive surface collections (shaded).

This increase in population nucleation would likely have been very useful for defensive purposes (Spencer and Redmond 2003, 2006). Moreover, the con-

struction and use of the large plaza (probably not much smaller than the Early MA I plaza area at Monte Albán itself) is evidence that the Tilcajete leadership enjoyed an increase in their power and authority between Rosario and Early MA I, which could also have been put to good use in resisting Monte Albán.

At the end of the Early MA I phase (ca. 300 B.C.), the El Mogote community appears to have experienced a major attack. The main plaza area was abandoned and a new plaza was built at the El Palenque site (Fig. 4), about 800 meters west and upslope from El Mogote:

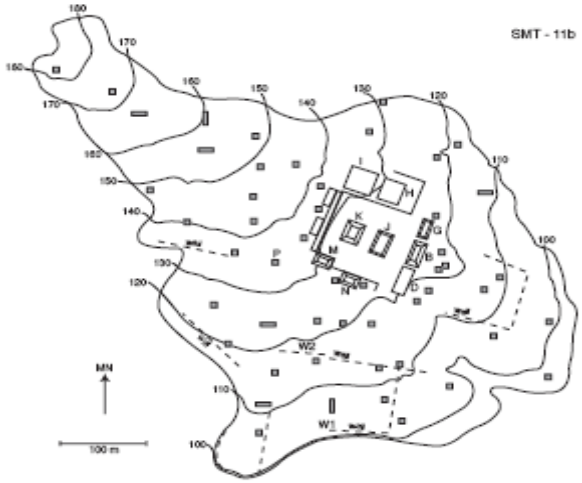

Figure 4. Schematic plan of the El Palenque site (SMT-11b), showing the plaza, major mounds, and locations of intensive surface collections (shaded).

El Palenque was occupied throughout Late MA I until it was abandoned in the first century of MA II. Occupied area grew to a total of 71.5 ha in Late MA I, including all of the El Palenque site and much of the habitation sector of the El Mogote site. Although the main plaza of the El Mogote site was apparently not used for ceremonial purposes in Late MA I, the main plaza at the El Palenque site shows considerable evidence of use throughout Late MA I. It is notable that the El Palenque plaza has the same orientation and a similar overall layout to the earlier plaza at El Mogote, and neither plaza resembles (either in orientation or layout) the Main Plaza at Monte Albán. We see this as evidence of a continuation of local public-ceremonial traditions at Tilcajete between Early MA I and Late MA I. Nevertheless, the two Tilcajete plazas also show some important differences. On the north side of the El Mogote plaza we recovered a high-status residence (in Area A) that grew through accretion to a final configuration of 3-4 rooms around a patio. Evidence is lacking of an overall architectural design: construction technique varies from one structure to another and they are not closely aligned at perpendicular angles. By contrast, on the north

side of the El Palenque plaza we excavated a palace (in Area I) that comprised some nine interconnected structures and associated features, all of which seem to conform to a pre-ordained design, with similar construction techniques and separate rooms and structures connected at tight perpendicular angles (Spencer and Redmond 2004b). On the east side of the El Mogote plaza we excavated (in Area B) a one-room temple, while on the east side of the El Palenque plaza we excavated (in Area G) a multi-room temple that had outer and inner rooms, flanked by a pair of smaller rooms. As Flannery and Marcus (1983) have pointed out, palaces and multi-room temples are two of the key diagnostic features of early state organization in Oaxaca. Our excavated evidence from Tilcajete indicates that state institutions made their appearance here between Early MA I and Late MA I.

Using our Tilcajete data as a "cultural barometer" of evolutionary development in Oaxaca (Spencer 2003), we have hypothesized that Late MA I was also when primary state formation occurred at Monte Albán, and the evidence in hand (though not complete) does not contradict that hypothesis (Spencer and Redmond 2004a). Accordingly, we view state emergence at Tilcajete as an example of secondary state formation, a key ingredient in the suite of resistance strategies employed against the expansionistic primary state of Monte Albán, This resistance, if our interpretations are correct, continued at Tilcajete until the El Palenque site was burned and completely abandoned in the first century B.C. A new site, Los Mogotes or Cerro Tilcajete (SMT-23) was founded at that time; Elson's research yielded several lines of evidence indicating that SMT-23 functioned as a secondary administrative center of the Monte Albán state during MA II (Elson 2003, 2006). SMT-23 is perched on a high ridge that overlooks the Ocotlán-Zimatlán subvalley and has uninterrupted visual connection to Monte Albán; our survey mapped a well-preserved road that ascended the ridge from the Monte Albán side, passed through the center of SMT-23 and then descended toward Tilcajete and the Ocotlán-Zimatlán subvalley.

Consistent with our hypothesis of resistance would be evidence of a constraint on interaction before MA II between Monte Albán and the Tilcajete area, especially compared to other areas that did not resist Monte Albán's expansionism. In Spencer and Redmond (2003, 2006) we compared two samples of Late MA I pottery, one from the El Palenque site and one from the La Coyotera site in the Cañada de Cuicatlán (see Fig. 1). We were especially interested in comparing the relative frequencies of crema pottery, a distinctive cream-colored ware made from a clay source near Monte Albán (Flannery and Marcus 1994:22). Crema pottery is often decorated with slipping and/or painting, and sometimes with incised designs as well. We found that the total percentage of crema wares was much higher in the La Coyotera sample than the El Palenque sample, even though La Coyotera is more than twice as far from Monte Albán as El Palenque is (Spencer and Redmond 2003:Fig. 16). These data are consistent with several other lines of evidence that indicate the Cañada was conquered by Monte Albán at the onset of Late MA I (Redmond and Spencer

2006; Spencer and Redmond 2001b), while the Tilcajete area remained independent until the beginning of MA II.

As a further test of the resistance hypothesis, let us examine the relative frequencies of slipped and/or painted crema ceramics between Early MA I samples from El Mogote and Late MA I samples from El Palenque. The occupational sequence implies that relations between the Tilcajete area and Monte Albán became increasingly hostile between Early MA I and Late MA I (Spencer and Redmond 2001a). The El Mogote plaza was abandoned after what seems to have been an attack, and the new occupation at El Palenque was built in a higher, more defensible location and protected by defensive walls. I propose that our resistance hypothesis would be consistent with a decline in the relative frequency of cremas between the Early MA I occupation at El Mogote and the Late MA I occupation at El Palenque. By contrast, we should expect an increase in the relative frequency of cremas between Late MA I and MA II, after El Palenque was burned and abandoned and the Tilcajete area became incorporated into the Monte Albán state, overseen by the newly-established secondary center of Los Mogotes (Cerro Tilcajete).

Fig. 5 presents a line graph showing the relative frequency of slipped/painted crema potsherds from excavated Early MA I deposits at El Mogote (SMT-11a), Late MA I deposits at El Palenque (SMT-11b), and MA II deposits at Los Mogotes or Cerro Ticajete (SMT-23); these data are compared to excavated samples for the same three phases from Monte Albán:

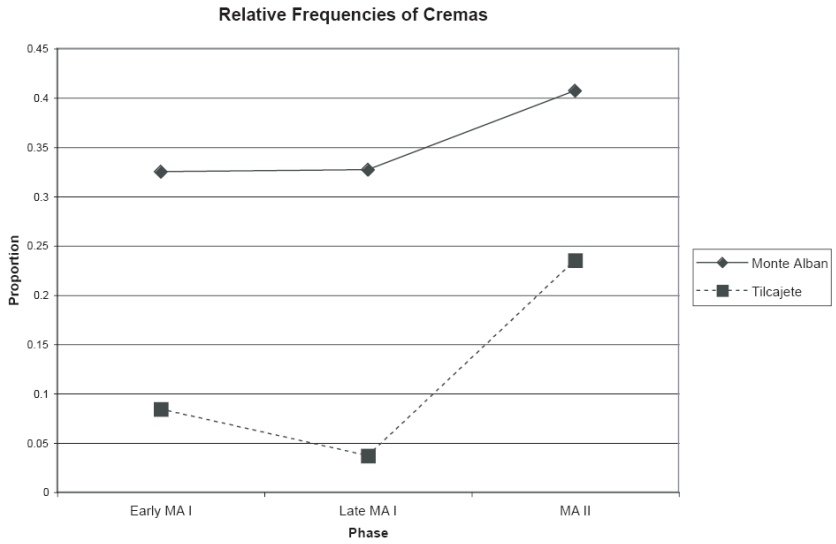

Figure 5. Relative frequency of slipped/painted crema ceramics in Early MA I, Late MA I, and MA II at Monte Albán and the Tilcajete sites. Data from SMT-11a (Early MA I) and SMT-11b (Late MA I) are from excavations directed by Charles S. Spencer and Elsa

M. Redmond. Data from SMT-23 (MA II) are from excavations directed by Christina M. Elson (Elson 2003). Relative frequency is obtained by dividing cremas by total diagnostic ceramics. Monte Albán data are from Caso, Bernal, and Acosta (1967:Tabla I).

The data from SMT-11a and SMT-11b were recovered during the 1993–2000 fieldwork there (Spencer and Redmond 2005), while the SMT-23 data were recovered by Elson (2003). The relative frequency was computed by dividing the total number of crema potsherds with slipped or painted surface treatments by the total number of diagnostic potsherds in the sample; diagnostic potsherds are all potsherds except undecorated body sherds. The crema types used in the analysis included C.2, C.4, C.5, C.6, C.7, C.11, C.12, C.13, and C.20, using the typology of Caso, Bernal, and Acosta (1967). If we look at the line on the graph for the Tilcajete samples, we see the relative frequency of cremas declining between Early MA I and Late MA I, but then rising between Late MA I and MA II (Fig. 5). The other line on the graph shows the relative frequency of cremas over the same three phases at Monte Albán itself. These data come from Tabla I in Caso, Bernal, and Acosta (1967: 97–98), which presents the relative frequencies of ceramic types from the "P.S.A." excavations at Monte Albán. In Fig. 5, the Early MA I (Ia) sample comes from Pozo 18 (Bolsa #73), the Late MA I (Ic) sample is from Pozo 17 (Bolsa #398), and the MA II sample is from Pozo 16 (Bolsa #326). For all three phases, it is clear that the Monte Albán samples have a higher relative frequency of crema ceramics than Tilcajete (Fig. 5). Between Early MA I and Late MA I, the proportion of cremas holds steady in the Monte Albán samples. By contrast, we have seen that the Tilcajete samples show a decline in the proportion of cremas between Early MA I and Late MA I, followed by a sharp increase in MA II. The results are consistent with a pattern of avoidance of interaction between Tilcajete and Monte Albán that not only continued but intensified between Early MA I and Late MA I. A reversal then followed, as the proportion of cremas in the Tilcajete sample rose sharply, reflecting an increase in interaction between Monte Albán and the Tilcajete area from Late MA I to MA II, when the Tilcajete area was incorporated into the Monte Albán state.

The crema data are thus consistent with a lengthy period of resistance—lasting through Early MA I and Late MA I—by the Tilcajete locality and, by extension, the entire Ocotlán-Zimatlán polity. Moreover, the decline in the relative frequency of cremas at Tilcajete between Early MA I and Late MA I is consistent with the proposition, put forth by Redmond and Spencer (2006), that Monte Albán shifted the focus of its warfare activities from raiding to conquest around 300 B.C., at the onset of Late MA I. Extrapolating from our Tilcajete data, I would hypothesize that the Tlacolula polity — whose capital, according to Marcus and Flannery 1996: 163), was the site of Yegüih (see Fig. 1) — also resisted Monte Albán throughout this period, though we are on shakier ground here, given the relatively little research that has been carried out on this topic in Tlacolula. Nevertheless, it is noteworthy that Elam (1989: 404) reported "the

first major buildup of defensible sites" occurred during Late MA I in all branches of the Valley and at Monte Albán itself, where a major wall was constructed. Three of the dozen defensible sites that he described for Late MA I are located in the Tlacolula subvalley (Elam 1989: Fig. 12.2).

In sum, the story of Monte Albán's rise to dominance over the entire Valley of Oaxaca is not one of steady progress. We see some initial success between Rosario phase and Early MA I, when the leadership of the Etla subvalley shifted its capital from San José Mogote to Monte Albán. Associated with this shift was a modest increase in political territory. The Rosario phase polity in Etla probably did not extend into the central area or outside the valley to the north (Fig. 6), while the Early MA I polity included both the central area and a small portion of the mountainous area north of the Etla subvalley (Fig. 7) (Spencer n.d.):

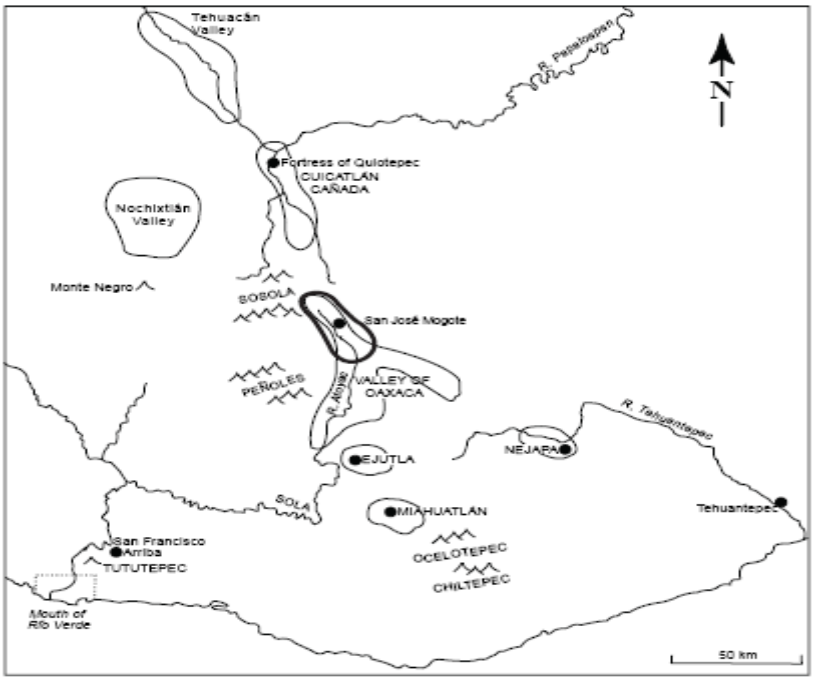

Figure 6. Proposed territorial extent of the Etla polity during the Rosario phase (700–500 B.C.).

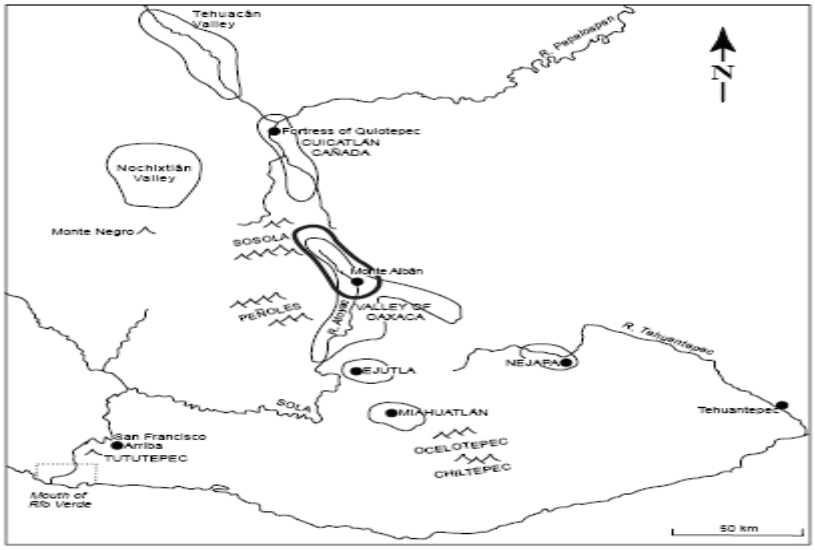

Figure 7. Proposed territorial extent of the Etla-Central polity during the Early MA I phase (500–300 B.C.).

As noted earlier, our evidence indicates that the Ocotlán-Zimatlán subvalley and (by extrapolation though less well documented) the Tlacolula subvalley resisted annexation in Early MA I, and continued to resist throughout Late MA I as well. The Monte Albán polity nonetheless grew considerably; the capital city itself expanded from 324 ha to 442 ha between Early MA I and Late MA I (Kowalewski *et al.* 1989:Appendix I). Moreover, the total occupation within the Etla-Central area also grew from 595 ha to 1620 ha between Early MA I and Late MA I (Kowalewski *et al.* 1989:Appendix I). This increase probably reflects a combination of in situ population growth plus immigration, as the leadership sought to enlarge its base of support through recruitment strategies. Yet, despite this population growth, there is no evidence that Monte Albán annexed the Ocotlán-Zimatlán and Tlacolula subvalleys until the beginning of MA II. Although I have outlined some of the strategies that these recalcitrant polities used to resist Monte Albán, we cannot ignore the fact that the population of Etla-Central area during Late MA I was much greater than that of the Ocotlán-Zimatlán subvalley and the Tlacolula subvalley combined, which amounted to 593 ha of occupation (Kowalewski *et al.* 1989: Appendix I). The question that emerges is: why was Monte Albán unable to subjugate the other two subvalleys for so long?

Applying the model

I will attempt to answer this question by applying Rashevsky's model of expansion and resistance (Equation 3), which focuses not on the absolute sizes of the expanding and resisting population, but rather on the rates of change in these populations. Let us examine the archaeological data from this perspective. As a proxy measure for population size, we will use the hectares of occupation presented in Kowalewski *et al.* (1989:Appendix I), which I have re-organized to allow subvalley comparisons for each phase.

First, let us look at the changes in estimated population sizes for Rosario, Early MA I, Late MA I, and MA II phases, dividing the total Oaxaca Valley sample into expansionistic vs. resistant sectors (Fig. 8):

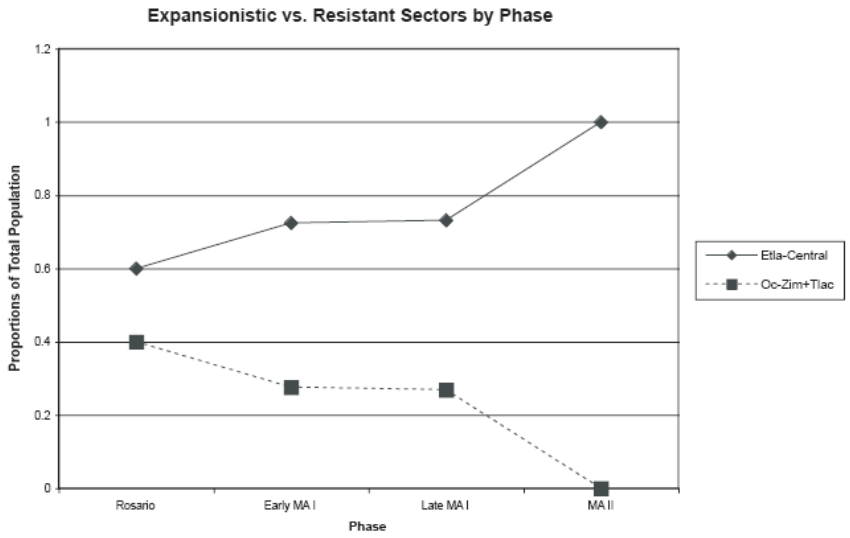

Figure 8. Relative populations of expanding and resistant sectors in the Valley of Oaxaca, by phase. The expanding sector is Etla-Central, while the resistant sector consists of Ocotlán-Zimatlán and Tlacolula. Population expressed as hectares of occupation; original data from Kowalewski et al. (1989:Appendix I).

The expansionistic sector consists of the Etla-Central area, dominated by San José Mogote in Rosario phase and Monte Albán in Early MA I, Late MA I, and MA II, while the resistant sector is made up of the Ocotlán-Zimatlán and Tlacolula areas, whose political capitals were Tilcajete and Yegüih, respectively. To facilitate comparisons among phases, the population data for the two sectors have been converted to proportions of the total for each phase; this conversion

is consistent with the assumption of a closed system that underlies Rashevsky's model.

The Etla chiefdom contained some 0.60 of the Valley's entire population during the Rosario phase, with the remainder located in the Ocotlán-Zimatlán and Tlacolula subvalleys (Fig. 8). In spite of the Etla chiefdom's numerical advantage, it did not take over the Ocotlán-Zimatlán and Tlacolula subvalleys. Our work at El Mogote has shown that the occupation increased by nearly 300% between the San José phase (1150–850 B.C.) and the Rosario phase, with no evidence of burning, violence, or abandonment at this time (Spencer and Redmond 2001a). This greater nucleation of population not only would have helped El Mogote defend itself against any attacks, but also would have contributed to El Mogote's ability to mount hostile actions of the sort that would have been instrumental in creating the buffer zone noted in the Central area and perhaps also the raiding in evidence at San José Mogote.

In Early MA I, the capital of the Etla polity shifted to Monte Albán and the Central area saw its first major occupation (Kowalewski et al. 1989:Fig. 5.1). Monte Albán expanded its control to about 0.72 of the entire Valley population, not only by annexing the Central zone, but also through substantial population growth that may reflect both increased immigration and changing household reproductive strategies (Blanton 1975). Between Early MA I and Late MA I, the relative distribution of population scarcely changed, as Monte Albán's share climbed only slightly to 0.73 (Fig. 8); we have seen that the El Palenque site yielded several lines of evidence revealing the resistance strategies used by this polity to maintain its autonomy through Late MA I. At the beginning of MA II, however, these resistance strategies were finally overcome and the entire valley fell under Monte Albán's control, raising its share to 1.0 (Fig. 8).

Of course, Rashevsky's model of expansionism and resistance is concerned not with population levels per se, but rather with rates of change in those levels. Specifically, the model suggests that the effectiveness of the expanding polity's coercive strategies is positively related to the rate of change in the relative population of the expanding polity relative to the resistant sector. In short, the success of an expansionistic strategy depends upon a positive rate of growth in the expanding the sector. To examine this proposition, I offer Figure 9, which presents the data on relative population distribution between the expansionistic and resistant sectors in terms of rates of change. The graph shows changes in the proportionate distribution of population per 100 years, calculated from one phase to the next.

Going from Rosario phase to Early MA I, we see that the Etla-Central polity showed a substantially greater increase in population per century than Ocotlán-Zimatlán and Tlacolula (Fig. 9):

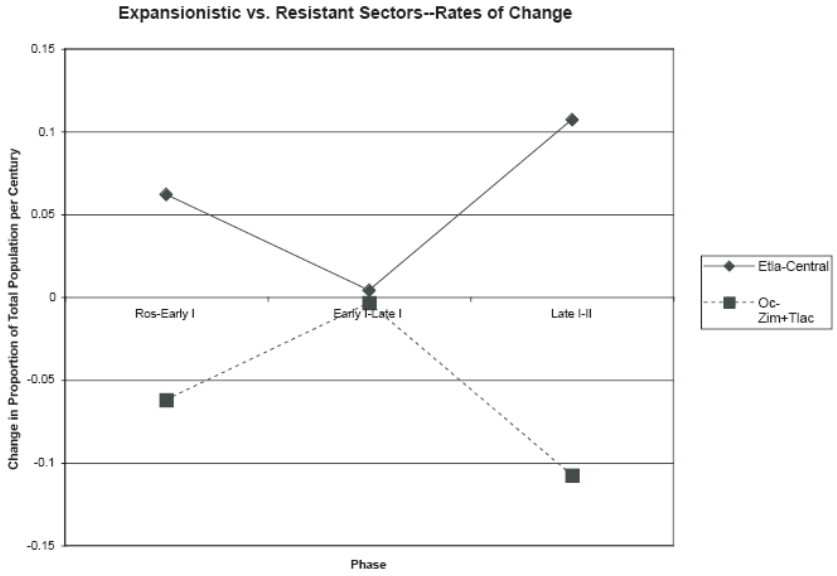

Figure 9. Rates of change of populations between phases in the expanding and resistant sectors in the Valley of Oaxaca. The expanding sector is Etla-Central, while the resistant sector consists of Ocotlán-Zimatlán and Tlacolula. Population expressed as hectares of occupation; original data from Kowalewski *et al.* (1989: Appendix I).

This surely reflects the initial success of the attempt by the Etla chiefdom to relocate its capital to Monte Albán and annex the Central zone. At the same time, this success must be seen as rather limited, in that it did not lead quickly to the annexation of Ocotlán-Zimatlán and Tlacolula. The reason it failed to do so may be related to internal difficulties within the Etla-Central polity that arose as a consequence of the relocation of the capital and attendant settlements. Elsewhere, I have shown that the distribution of population was not well aligned with the distribution of agricultural resources within the Etla-Central polity during Early MA I (Spencer n.d.). Using the data collected by Nicholas (1989), I computed correlation coefficients between the estimated population and the estimated potential population across all her 4 x 4 km grid units for Rosario, Early MA I, and Late MA I phases, subdivided by subvalley. As Fig. 10 shows, the Etla-Central area experienced a sharp decline in this correlation coefficient in Early MA I, while the other two subvalleys exhibited a positive trend overall.

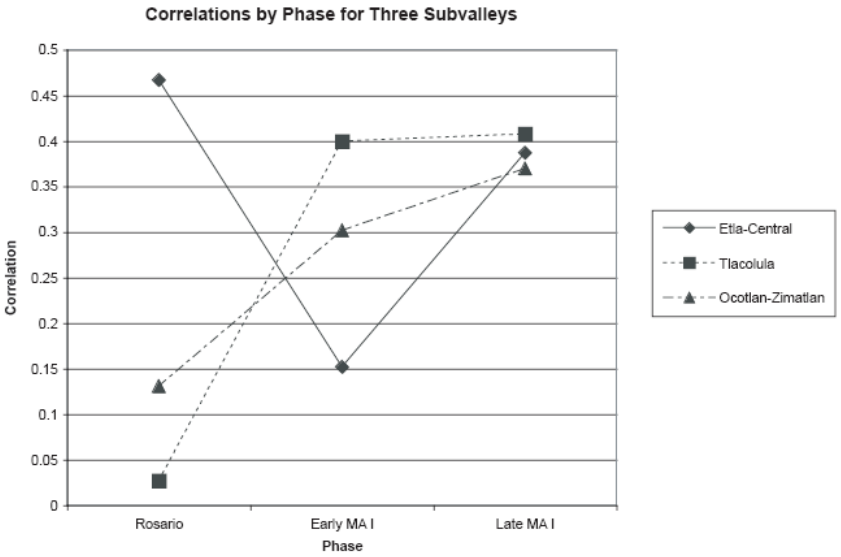

Figure 10. Correlations between estimated population and potential population by phase for the Etla-Central, Ocotlán-Zimatlán, and Tlacolula subvalleys. Original data provided by Nicholas (1989).

I suggest that, even though the Etla-Central polity experienced initial success in adding to its relative share of the Valley population between Rosario phase and Early MA I, this increased population was not distributed optimally with respect to the agricultural resources within the Etla-Central zone. Such a lack of correspondence meant, for example, that fields were often not convenient to households, introducing inefficiencies into the overall system of agricultural production and distribution. This discordance between population and resources was probably an unintended consequence of the successful attempt to expand the Etla polity; it may well have seriously threatened the stability of that polity, and the legitimacy of its leadership, as Early MA I wore on. Consistent with this possibility would be Marcus's (1974) interpretation of the Early MA I Danzantes inscriptions, a gallery of stones showing sacrificed captives that represents 80% of all the carved stones from all prehistoric phases at Monte Albán. She suggests that the massive display was a form of propaganda, which Monte Albán's leaders sponsored as a way of reinforcing their authority at a time when their power was in reality somewhat weak.

Going from Early MA I to Late MA I in Figure 9, we observe a sharp drop in the growth rate of the proportion of the Valley's population controlled by Monte Albán (Etla-Central), coupled with a dramatic rise in the growth rate exhibited by the resistant sector composed of the Ocotlán-Zimatlán and Tlacolula

subvalleys. In line with Rashevsky's model (Equation 3), I suggest that this decline in the growth rate of Monte Albán's share directly reflects a decline in the effectiveness of the coercive strategies that Monte Albán aimed at Ocotlán-Zimatlán and Tlacolula. Even though Monte Albán controlled a much larger population than the resisting subvalleys, its ability to subjugate the entire Valley seems to have depended on sustaining a positive relative rate of annexation. Instead, the resisting subvalleys increased their populations in Late MA I at a rate that maintained the same relative distribution that was observed between Monte Albán and the resisting subvalleys during Early MA I. In sum, the relative rate of population growth actually declined for Etla-Central, while it increased for the resisting subvalleys. This demographic evidence of successful resistance is consistent with the independent archaeological evidence of resistance strategies that we recovered during the Tilcajete fieldwork (Spencer and Redmond 2003, 2006).

Rashevsky's model would predict a continuation of the détente between expansionistic and resistant sectors as long as the non-compliant polities persist in matching the expansionistic polity's rate of increase. Yet, we know in the Oaxaca case that Monte Albán succeeded in annexing the Ocotlán-Zimatlán and Tlacolula sectors by MA II (Spencer and Redmond 2001a). So, why did the situation of détente not continue? To seek an answer to this question, let us consider the model's limitations, in particular its characterization of the dynamic between expansionistic and resistant polities as a closed system. In the Oaxaca case, we know that the Oaxaca Valley (with its three subvalleys) was hardly a closed system. There were numerous neighboring regions and it was into those regions that Monte Albán began to expand during Late MA I (Spencer and Redmond 2001b, 2004a). Among the first regions to fall under Monte Albán's control were the Cañada de Cuicatlán, the Peñoles region, and the Sola Valley (Fig. 11). These places were relatively easy targets for Monte Albán because they had much smaller populations and were not as centralized politically as were Ocotlán-Zimatlán and Tlacolula. At the same time, the Cañada, Peñoles, and Sola lay much farther from the Zapotec capital. In order to conquer and administer these distant territories over the long term, the Monte Albán leadership must have had to develop a full-time military along with internal administrative specialization and the attendant capacity to delegate partial authority to frontier administrators: in short, what was needed was the bureaucratic form of government known as the state (Spencer 1990; Spencer and Redmond 2003; Wright 1977). The labor and resources gained from these annexed regions undoubtedly helped to defray the considerable costs of the militarization and bureaucratization of the Monte Albán polity, which became much more powerful during the course of Late MA I. By MA II, Monte Albán was ready to direct its expansionistic aspirations to the east and south, and it found great success in doing so, annexing not just Ocotlán-Zimatlán and Tlacolula, but several other regions as well (Fig. 12):

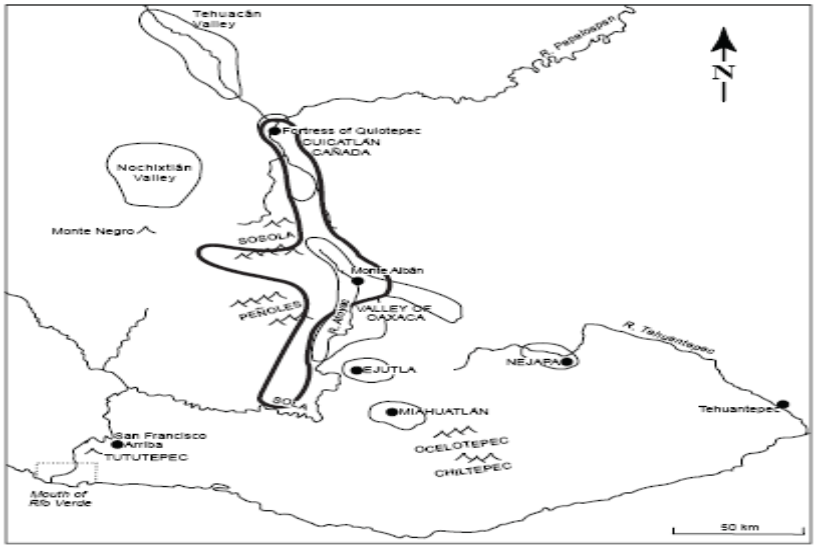

Figure 11. Proposed territorial extent of the Monte Albán polity during the Late MA I phase (300–100 B.C.).

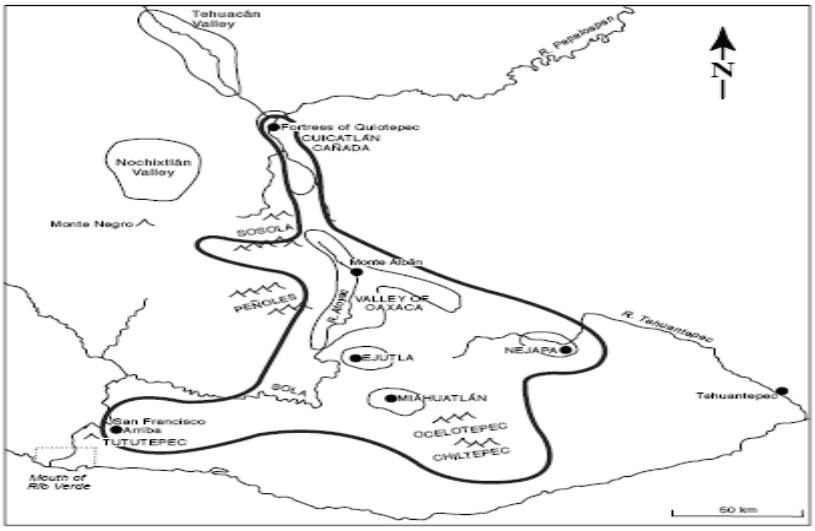

Figure 12. Proposed territorial extent of the Monte Albán polity during the MA II phase (100 B.C. – A.D. 200).

Conclusion

The data we have examined are consistent with the expectations of Rashevsky's model: we observed a decline between Early MA I and Late MA I in the relative growth rate of the expansionistic polity in Etla-Central compared to the resisting sector in Ocotlán-Zimatlán and Tlacolula. In addition, we recovered independent evidence of intensifying resistance strategies over the same time frame at Tilcajete, the capital of Ocotlán-Zimatlán. We have also seen that, after some initial success, Monte Albán's expansionistic strategies began to lose momentum in the Valley. It appears that an effective resistance did not require Ocotlán-Zimatlán and Tlacolula to grow their populations to an absolute size approaching that of Etla-Central. Rather, the results indicate that Monte Albán could be effectively resisted if the non-compliant areas were able to *match the rate of population increase* in the Etla-Central subvalley and, at the same time, combine this achievement with other strategies of resistance (defensive constructions, secondary state development, maintenance of local traditions, avoidance of exchange with the expansionistic power, etc.).

It is also worth noting that our application of Rashevsky's model did not require us to generate precise predictions to test against the archaeological record. Instead, the model's contribution was both less specific but more heuristic in nature: it highlighted the relationship between the effectiveness of the expanding polity's coercive strategies and the relative rates of population increase in the expansionistic *vs.* resistant polities, thus giving us a new lens with which to view the archaeological record. This lens brought into focus the correspondence between the decline in the relative population growth rate of the expanding polity and the evidence of the resistance strategies utilized by the recalcitrant sectors of the Valley. This correspondence between independent lines of evidence helps us understand how a situation of détente between the expanding and resisting polities within the Valley could have persisted for so long, leading Monte Albán to conquer more distant extra-Valley regions and evolve into a state in the process.

To sum up, when researchers examine other cases of expansionism, I suggest they pay special attention to changes in the relative growth rates of the expanding vs. the resisting polities. When doing so, they should seek to test what is probably the key hypothesis that emerges from this paper: that the success of an expansionistic initiative is directly dependent upon a positive rate of growth in the expanding sector relative to the resisting sector and not simply upon an absolute difference in population sizes. A corollary would be that a slowing of the relative rate of incorporation or annexation is likely to be fatal to the initiative, even if the expanding polity is much more populous than the resisting sector. Broadening our viewpoint, I suggest that this model might even shed light on some recent episodes of expansionism. I am thinking here of such seemingly disparate cases as the American intervention in Vietnam, the Soviet Union's attempt to subjugate Afghanistan, the recent Israeli invasion of Lebanon, and the

ongoing American-led invasion of Iraq. In all these cases, a vastly more powerful expansionistic force encountered stiff resistance and the relative pace of incorporation declined. In the first three cases, the expanding polity eventually retreated; the fourth case is still unresolved, though there is little doubt that the pace of subjugation has slowed considerably and the prospects are not encouraging for the intervening polity.

A positive relative growth rate is one clear sign that the strategy of expansionism is succeeding; it has a major impact on morale and is crucial for maintaining enthusiasm within the population of the expanding power. Alternatively, a slowing success rate may be readily perceived as a stalemate (or "quagmire"). Waning popular support would be the likely result, and eventually the aggressor power could find itself in ignominious withdrawal. The Zapotec case suggests that this sorry fate might be overcome if the aggressor polity turns away, if only for a while, from the resisting sector and launches a new initiative against other, weaker targets. Such exploits might yield new labor and resources that could underwrite an increase in the expanding polity's power and pave the way for a renewed thrust against the resistant sector, perhaps this time with results that prove more gratifying to the aggressor.

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The Silk Roads: A mathematical model*

Artemy Malkov

This article concerns the problem of mathematical modeling of historical processes. The dynamics of the Silk Roads is described by means of formal spatial equations. Historical data conveys the facts that the location of the trade routes known as the Silk Roads altered profoundly enough from epoch to epoch. These changes arise from a number of causes – population oscillations, economic trends, diseases and warfare – all these factors affected the dynamics of the Silk Roads and sometimes predetermined its rise and demise. Mathematical simulation of the Silk Roads could help to distinguish the most significant factors and to estimate where and when these factors were especially efficient. In this paper we examine the hypothesis considered by Jeremy Bentley. This attitude implies that one of the most important causes of the Silk Road prosperity was the development of large-scale empires. It promoted the trade greatly. On the one hand big empires stimulate exchange of commodities for the rise of supply and demand of bulk and prestige goods, on the other hand they construct roads and related infrastructure that also induces active trade. Finally they bring stability to vast areas; it is of high importance for negotiations as well. The model takes all these aspects into account and demonstrates the oscillations of the Silk Roads activity induced by the rise and demise of large empires such as Roman, Parthian, Mongol empires, Han and Tang dynasties etc. Simulation gives also some additional curious results.

The subject of historical simulations does not engross wide attention yet, but it seems to be very promising, owing to the actual interest in mathematical applications in social sciences. Obviously there are no exact formal laws or formulae as yet that can describe the behavior (or widely the evolution) of the social medium. However, the experience of exact sciences shows that possible formalization of the knowledge could yield the results more intensional than ever before. It is enticing to operate with some "social equations" and to obtain formal results and forecast for social systems, the same way as we do with physical laws and systems. For the moment we only start this way to formal social science and the attempts of historical simulations could supplement the efforts of social modeling with extensive data and fresh ideas.

Mathematical modeling of social processes is a discipline that emerges naturally due to onrush of mathematical methods and computing machinery firstly and considerable complication of social interactions, risks and threats growth secondly. Great success in modeling of complex physical processes induced at-

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tempts of applying mathematical apparatus to the social sciences. However, while the first steps of social modeling have shown that sometimes simple linear equations can give adequate predictions, these steps have also exposed the fundamental problems. One of such problems is a "human factor". Mechanical systems have no free choice, so traditional physics-mathematical apparatus does not allow describing complex systems possessing the freedom of choice. How can one describe social systems by means of mathematics then? Fortunately, modern physics (not only physics but also biology, system analysis, cybernetics, synergetics etc.) successfully deal with complex open systems that have no deterministic description and so to say enjoy freedom of choice (Every sufficiently complex system has free choice due to internal instabilities. The effect of "mixing layer" allows a complex system to generate information and so to make choice). So the difficulty of the mathematical analysis of society is an inapplicability of deterministic approach to the social systems. This fact seems to contradict traditional concepts of physical science. The law is considered there as a direct cause-and-effect relation. Oppositely traditional social sciences pay attention firstly to the particularities of the social phenomena. Every attempt of cause-and-effect description is inevitable nullified by numeral exceptions. This is an immanent property of complex systems. Usually there are no obvious pure factors that affect social events. Necessity and determinism is complemented by random fluctuations and plurality of possible life-lines. But this is not a reason to declare indeterminism and impossibility of any kind of laws. Modern physics however already has wide experience of complex systems description and related methods are well enough elaborated. This success makes mathematical methods attractive to economists, sociologists, psychologists, etc. So fortunately specialists both in physical and social sciences have found now common approach to mathematical description of social processes. It is rather difficult to find understanding and common language but the great number of interdisciplinary works denotes the efficiency of such approach.

Mathematical modeling of social processes is widely used first of all for pragmatic forecasting. The most mathematized social discipline is economics. The section of economics of the most interest and attention is the stock exchange dynamics. This is the area of the fastest enrichment or bankruptcy. So the forecast here is pragmatically most demanded item.

The opposite side of the mathematicians' interest in the modern society daily needs is the following contradiction. Without basic formal theory of society they try to construct models of very complicated processes. It is hardly possible. Modern society is too complicated a system, the result of continuous evolution. It includes both backwashes of the ancient social structures and influence of modern conditions. Evolution changes the society, but the original structure is not replaced, it is only transformed and developed. So without a basic formal theory of less complicated former society we can hardly construct formal theory of modern society. Another problem of the modern society theory is that every theoretical hypothesis must be proved by a successful prediction. For

macro-processes the time of perdition also has macro-scale, so the today's hypothesis can be proved only in years or centuries. So there is no possibility to verify and modify the theory. For small-scale processes, prediction prove demands less time, but the behavior of small-scale social systems usually highly depends on the individual behavior of the humans – members of the system. But here we face again the problem of the human factor, which is still unsolved.

So in order to construct formal theory it seems reasonable to consider macro-systems and to work with pre-modern less complicated societies. This way we can avoid both the problem of long-term prediction (we have information on the "future" dynamics of the pre-modern social systems) and the problem of the human factor (which is not so actual for a large-scale system). Further the construction a theory *from historical simple social systems to modern hierarchical complex systems* will take place. History gives us an extensive set of information, which is practically sufficient both for construction and verification of the formal theory. The historical process is unique and unrepeatable but the same basic processes are observed in different societies in different ages. This denotes that there are some basic laws of social dynamics, and these laws are to be found and formalized.

So the perspectives of historical modeling are very promising. However there still exist few scientific works of this kind (Guseynova, Ustinov, and Pavlovskii 1981; Nefedov 2004; Turchin 2003, 2005; Turchin and Korotayev 2006; S. Malkov 2002; Korotayev, A. Malkov, and Khaltourina 2006a, 2006b; Korotayev and Khaltourina 2006). The lack of historical numeric data is one of the most important problems. Formal theory could help to reconstruct some data, but it has not been developed yet. For these reasons it is now important to find the usable research direction, well-behaved process, most described object. Being formalized these newly obtained objective laws could help to derivate new laws and reconstruct historical data.

This paper is a work of this kind. There are two goals – to propose some formal apparatus and to apply it to some historical processes. As it was noted above the attempts of macro-systems description seem to be the most creative approach under the current conditions. There are some brilliant examples of mathematical modeling of the historical dynamics of large-scale societies (Nefedov 2001; Turchin 2003, 2005; Turchin and Korotayev 2006; S. Malkov 2002). However, they basically consider the relations between internal factors and indices of the society. Actually, the external factors such as geographical properties are not taken into account. They are included into the model but do not play the main part. It is acceptable for large practically isolated agrarian societies, which are considered in these works. However, it is evident that there existed not only self-sufficient agrarian states but also a great number of societies that were essentially dependent on transit trade between agrarian states. Societies of this type obviously depend on geography and location of agrarian neighbors. Consequently the main factor here is a spatial factor.

Thus the main intention of this work is to consider spatial historical dynamics and to propose a model of spatial trade. Being constructed as a common model it will be adapted below for a real historical process.

In order to construct the model it is reasonable to base on related disciplines. For spatial trade model the spatial economics is a basic discipline. The experience of mathematical physics that deal with spatial processes will be also valuable.

A continuous model of transportation was proposed and developed by Martin Beckmann (Beckmann 1952). It concerns the process of commodity transportation in some geographical region (e.g. urban territory). However, it was constructed for trade flow optimization and do not pretend to describe the evolution of real flows and trade routes. So the model must be modified and generalized in order to describe spatial historical dynamics.

Beckmann suggests that some commodity sources (producer) and sinks (consumer) should be located at some points of considered geographical region. Every point of region is also characterized by a trough-passing commodity flow and transportation cost trough the point. The problem considered by Beckmann was to find optimal flows under given distribution of producers and consumers and given distribution of transportation costs. Beckmann proposes his model of the spatial market in assumption that "traders must not suffer losses. This means that the gain form trade exactly equals transportation costs…" (Beckmann and Puu 1985: 16). This model gives the stationary distribution of commodity flows. Beckmann proves that this distribution is optimal as the transpiration costs are strictly minimal along every flow line.

This model is wholesome for the field of spatial economics. It can be used for effective trade flow control. Nevertheless there are some limitations that preclude from applying it to the problems of historical dynamics.

Firstly it is a stationary model and it does not describe the dynamics itself. History is a non-stationary process, evolution, at times slow and at times fast transient. To describe history the model must be dynamical.

Secondly the requirement of optimal route choice is unrealistic under the conditions of the lack of information, while the lack of information is inevitable for real processes. Beckmann assumes that the trader chooses the route of strictly minimal transportation cost. But it is clear that a real trader (especially an ancient one) deals only with rough estimations of transportation costs. The model proposed by Beckmann gives an ambiguous solution for "neutral circuits" (Beckmann, Puu 1985: 38) when between two points of a region two distinct flow paths of equal cost exist. In this case however an infinitesimal variation of the cost along one of these paths destroys the neutral circuit and the trader will unambiguously choose the best path. In other words, micro variations cause dramatic macro changes. This situation is obviously unrealistic. A real trader more likely chooses the route randomly (in a certain sense), but the probability of his choice essentially depends on a roughly estimated transportation costs along the corresponding path. Not only transportation costs but also

risks, habits, prestige and other factors affect the choice and they are the more significant the closer the costs of two equivalent paths are.

Finally the use of transportation costs as a territory characteristic works well only under the conditions of the modern society. It is problematic enough to reconstruct such data for ancient ages. So there is a need of transportation costs estimation method. It might be reasonable to introduce into practice another meaningful parameter that could describe the trade conductivity of a territory and could be less dependent on currency and prices, more considering non-monetary factors of choice (risk, prestige etc.) and measurable or estimable at the same time.

Thus Beckmann's model requires modification and generalization in order to be applicable to the problems of spatial historical dynamics.

Let us consider a closed region of spatial one-commodity market. Suggest

T(x,y) is the density of commodity,

q(x,y) is the excess density of production, i.e. the difference between the density of production and the density of consumption (*q* is positive if production exceeds consumption at this point, otherwise *q* is negative),

p(x,y) is the distribution of commodity price

The divergent law for this process:

$$\frac{\partial T}{\partial t} = -\mathrm{div}\mathbf{J} + q$$

where **J** is the commodity flow vector.

This well-know equation describes a continuous flow of any substance (e.g. heat flow, liquid flow etc.) In the given case it can be verbalized as follows:

"The increase $\frac{\partial T}{\partial t}$ of commodity density is the sum of the increase due to production *q* and the increase due to difference $-\mathrm{div}\mathbf{J}$ between the incoming and outgoing flow"

The price dynamics can be linearly considered as

$$\frac{\partial p}{\partial t} = \gamma(D - S)$$

where *D* is the demand density at the point, *S* is the supply density and γ is the constant of proportionality that implies the supply-demand disbalance sensitivity of market prices.

This equation can be verbalized as:

"The prices grow if demand exceeds supply and fall if demand is less than supply"

In assumption that there are no commodity selling limitations suggest

$$\frac{\partial T}{\partial t} = S - D$$

That is "Overstocking takes place if supply is greater than demand and there are active sales if demand exceeds supply"

Finally, main assumption of the model is that

$$\mathbf{J} = k \cdot \mathrm{grad} p \,,$$

where commodity conduction coefficient k is the coefficient of proportionality. It will be discussed below.

This equation means that the flow of commodity is proportional to the gradient of the commodity price. The verbalization is the following:

"The flow of commodity transportation between adjacent points is the more intensive the greater the difference of prices at this points is."

This equation is the key difference from Beckmann's model. Beckmann assumes that the flow must have the same direction as the price gradient (as it is known, the gradient vector is directed along the lines of the quickest ascent – in the considered case the lines of the quickest price rise).

Our assumption (unlike Beckmann's one) implies that not only the direction of the flow is the same as the gradient direction, but also the absolute value of the flow is proportional to the amount of the gradient.

This refinement looks as a slight modification but it is very essential. Namely, this modification withdraws the problem of "neutral circuits" and the problem of decision making under the conditions of the lack of information. That is the traders can define the amount of the inter-local trade using the local properties of the market. They do not demand the secondhand information about adjacent and remote markets.

One of the advantages of the proposed model is that it does not fundamentally contradict Beckmann's model. Moreover, Beckmann's optimal stationary solution can be reached in this dynamical model as the time tends to infinity. That means that the system at whole eventually comes to the stationary optimal solution where the cost of transportation is minimal. It is a more realistic behavior – suppose the system was initially stable but suddenly a considerable change of conditions (new production startup, bankruptcy of an enterprise, armed conflict at the region of the trade route) occurs. Due to the lack of information the flows do not come to the optimal configuration immediately after the change of conditions but as the time passes (if conditions do not change

dramatically in the sequel) the flows stabilize and become optimal under established conditions. Note that parameter γ corresponds to the speed of the information propagation and system response. The more the γ value is the faster the optimal steady-state pattern establishes.

Assembling all previous equations we can derive:

$$\frac{\partial p}{\partial t} = \gamma(\mathbf{div}(k \cdot \mathbf{grad} p) - q)$$

This equation is well known. This is a "heat conduction equation" that describes the evolution of the spatial system with heat sources and sinks and with an uneven heat-conduction coefficient. Heat equation is well studied (Tikhonov and Samarskii 1951) theoretically and practically (i.e. there exist strong analytical treatments and computational methods). This experience gives us a wide field for effective application of the equation.

So the commodity-conduction coefficient is mathematically equal to the heat-conduction coefficient. Thus it will be discussed with respect to this analogy. Commodity-conduction coefficient (CCC) is a very important factor for a spatial market. The higher this coefficient is the more profitable the conditions both for producers and consumers are. Low CCC results in low prices for producers and high prices for consumers. The difference between these prices corresponds to transportation expenses. This situation obviously is not favorable and can reduce both production and consumption. CCC is related to Beckmann's transportation costs coefficient. However CCC is more general. It involves not only economical properties but also non-monetary aspects such as risks, prestige, habits etc. Moreover, CCC is more measurable for historical processes. For example if we have an estimation of the amount of the commodity flow between two enough isolated towns and an estimation of the price at each town – we can define the value of CCC along the route connecting these towns. Certainly it is not so easy as described above because the flow and the prices are not constant at time, but the model is dynamical too so it is possible to distinguish the causes of changes – external conditions influence or evolution of the market itself.

Our next step is to approve the model. Let us apply it to some real historical process. If the results of modeling will be appropriate then we can believe the model is correct. So we need to pick out an example of a spatial market system that is large enough spatially and temporally, well enough described and analyzed. There is a system that perfectly satisfies all these conditions. It is a famous trade-route system known as the Silk Roads.

The Silk Roads is a unique phenomenon. It is the most long-life large scale trade-route system in the world. It was not only a merchant route but also a basic factor of the unification of Afroeurasia (Chase-Dunn, Hall 1997). The Silk Roads is the system of trade routes with complex historical dynamics.

There were three main epochs of the Silk Roads history. The intensification of the Silk Roads trade took place at each epoch. At the end of each epoch the trade diminished considerably. These epochs are: the epoch of the ancient Silk Road (II B.C.E. – III C.E.), the epoch of Islam propagation (VI – IX C.E.), the epoch of the Mongol Empire (XI – XIV C.E.). At each epoch the pattern of the main trade routes was different – strictly speaking these changes will be the object of our further attention.

What were the main factors affecting the intensity and location of the routes? As usual for complex systems there are too many factors that can de involved in consideration. However, this plurality is unacceptable when we deal with a mathematical description as we do now. We cannot use huge mathematical constructions and our first step is to reduce the system and to select one or several governing factors. Fortunately, for the Silk Roads this factor was found.

Calculations show that the main factor that predetermined the location of the Silk Roads was the spatial layout of large-scale empires. This point of view is similar to that of Jerry Bentley (1993), who examined cross-cultural links such as the Silk Roads and implied that the large-scale empires were presumably the main factor of the Silk Roads existence and dynamics: "The era of the ancient silk roads – roughly 200 B.C.E. to 400 C.E. – thus figures as the first major period of cross-cultural encounter. The consolidation of large imperial states pacified enough of Eurasia that trading networks could safely link the extreme ends of the landmass", "Beginning about the sixth century, however, a revival of long-distance trade underwrote a second round of intense cross-cultural encounters. The revival of cross-cultural dealings depend again on the foundation of large imperial states…", "The second period did not so much come to end as it blended into a new era – roughly 1000 to 1350 … The distinctive feature of this era … had to do with the remarkable military and political expansion of nomadic peoples, principally Turks and Mongols, who established vast transregional empires and sponsored regular and interactions between peoples…" (Bentley 1993: 26-27).

Unquestionably the empires themselves are not an independent phenomenon. There are many other factors that induce the rise and fall of empires. Nevertheless here we do not take these factors into account. We only derive that the existence of empires predetermines the pattern of commodity-flows. It does not matter for us why they exist and how they appeared – it is a subject for another mathematical model. For this case we propose the general equation of spatial demodynamics:

$$\frac{\partial u}{\partial t} = \mathbf{div}(k \cdot \varepsilon \cdot \mathbf{grad} u - k \cdot u \cdot \mathbf{grad} H) + q$$

This equation describes spatial evolution of population density u. Here k corresponds to the migration-conductivity, H – the spatial utility function, ε – the

amount of undirected migration, q – the difference between birth and mortality rates.

Using this equation it could be possible to solve some problems of spatial historical dynamics, in particular the problem of empire formation. However, the given paper does not involve the application of this equation. Further we assume that the bounds of all empires are given exogenously.

The mechanisms of the empires' influence on the trade are also comprehensive. Large empires demand and supply more goods for prestige-goods trade networks, large empires support roads and other infrastructure, large empires bring stability to the areas of commerce, etc. There are many other components of the beneficial influence of large empires, but fortunately most of them can be easily described in terms of the spatial trade model, which was proposed above:

- *Large-scale empire increases the commodity conductivity of the territory inside its bounds.*

This means that the commodity-conduction coefficient of a geographical region increases when this region belongs to an empire (e.g. after being conquered by imperial troops) and it decreases back when the empire losses control in this region (e.g. after the imperial collapse).

The increase of conductivity results in the following consequences. The transportation costs (as it was discussed above) decreases when the conductivity increases. So the expenses of traders also become lower. Imperial interlinks are faster and safer. The roads inside the imperial bounds become more attractive for traders even if a shorter path outside the empire exists.

All these factors can cause changes. The original location of main commodity-flows can become less profitable and therefore instable after the formation of an empire nearby. The general flow pattern can change considerably form epoch to epoch as the empires rise and fall, even if the locations of the main commodity producer and consumer remain constant.

So the simulation of the Silk Roads involves the following assumptions:

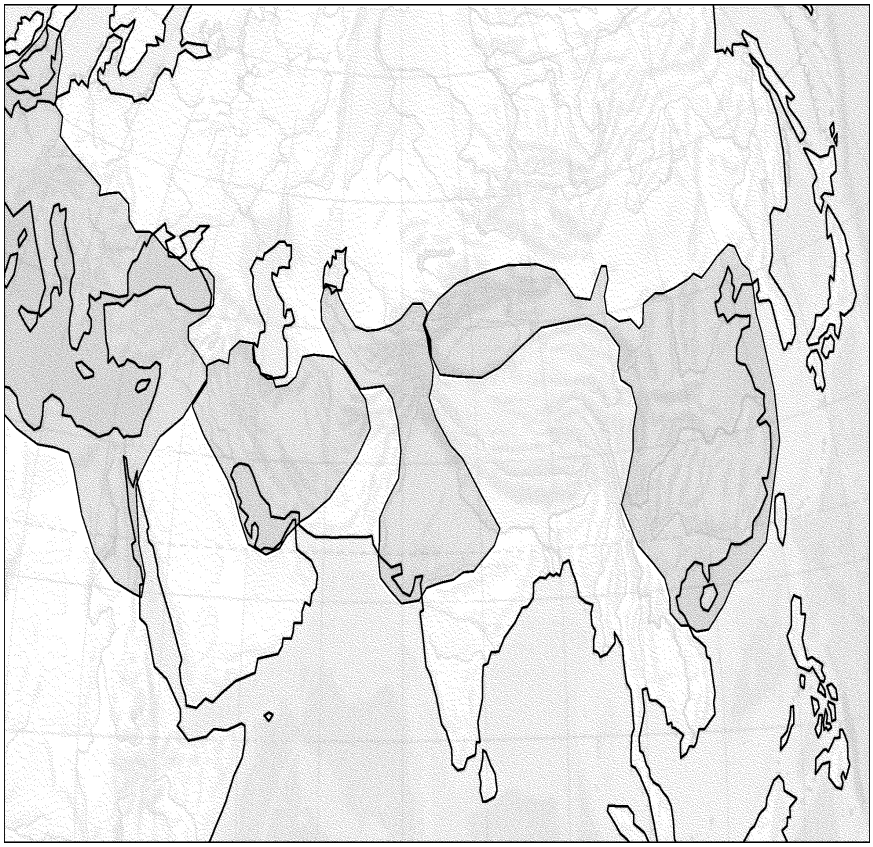
1. The model of spatial trade is used as a mathematical basis.
2. Initial conductivity of each geographical point is estimated using the conditions of the respective territory.
3. Three historical epochs are considered – the epoch of the ancient Silk Road, the epoch of Islam, and the epoch of Mongols.
4. For each epoch two points are assigned – the point of the main production of commodity and the point of main consumption of commodity.
5. For each epoch the layout of main empires is assigned – the commodity-conductivity coefficient increases inside the empire at the respective epoch.

Mathematically the model corresponds to the parabolic equation with a point source, point sink, uneven coefficient and the boundary condition of the formal

flow equaling zero. The simulation was counted out using the finite-difference methods.

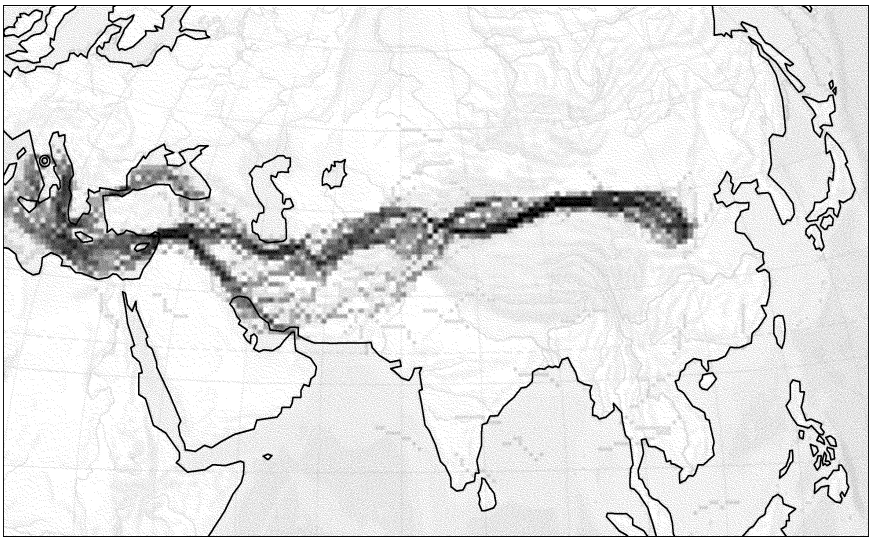
The results of calculations are given below. First picture illustrates the lay-out of the main empires of an epoch. Second picture corresponds to the numerical results. Third picture corresponds to the empirical historical data (World History 1956–1958).

II BCE. – III CE. The epoch of the ancient Silk Roads

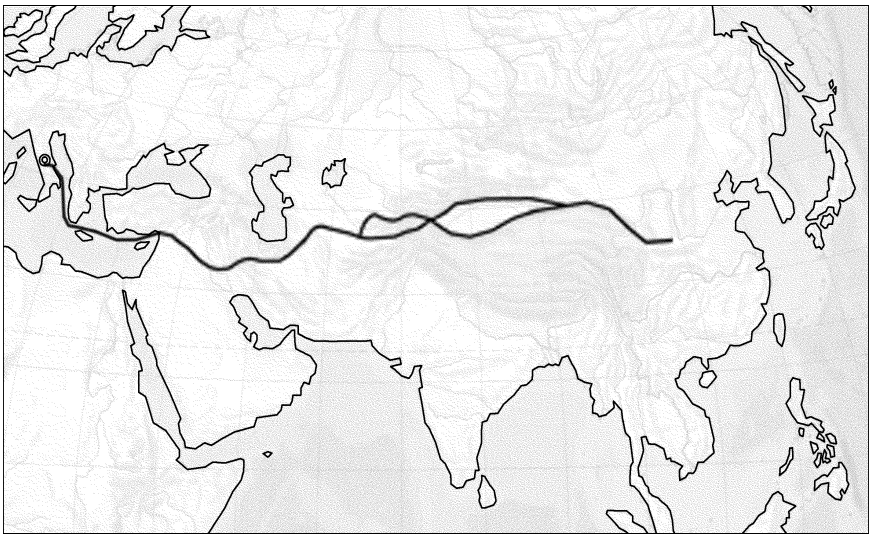


The main empires of the epoch of the Ancient Silk Road were the Roman, Parthian, Kushan and Han Empires. It was the first time in history that Eurasia became an integrated system. However, only prestige-goods networks were integrated. Military networks and bulk goods networks of these world-systems were much smaller than prestige-goods network. (Chase-Dunn, Hall: 2003).

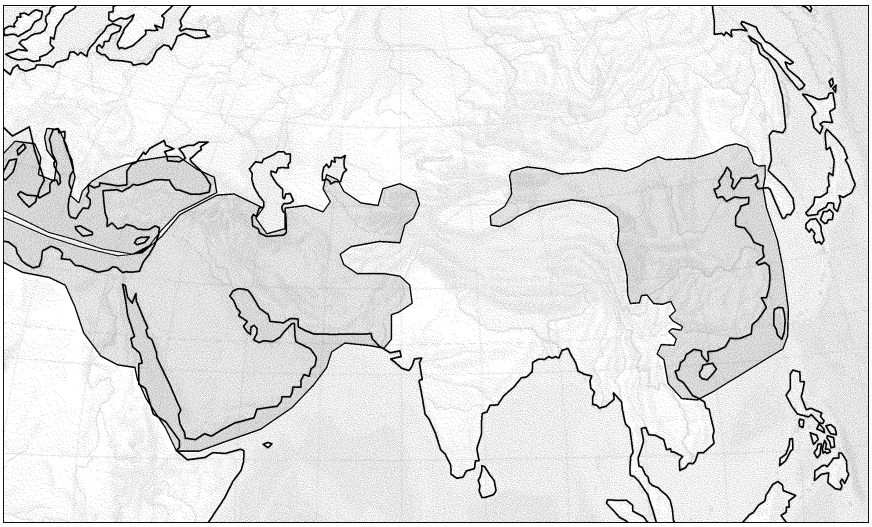
Calculation results for the first epoch.
The darker the point, the higher the commodity transportation through the point



Historical data on the Silk Roads location for the first epoch

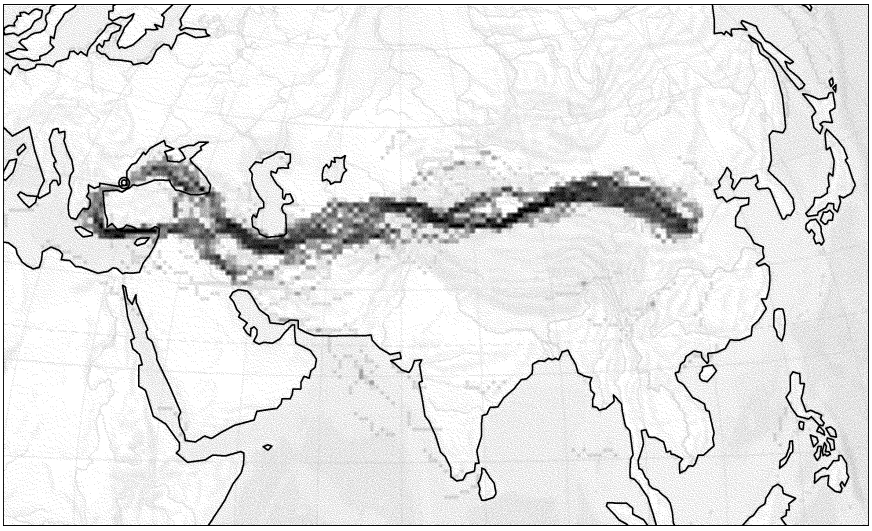


VI – IX CE. The epoch of the rise of Islam

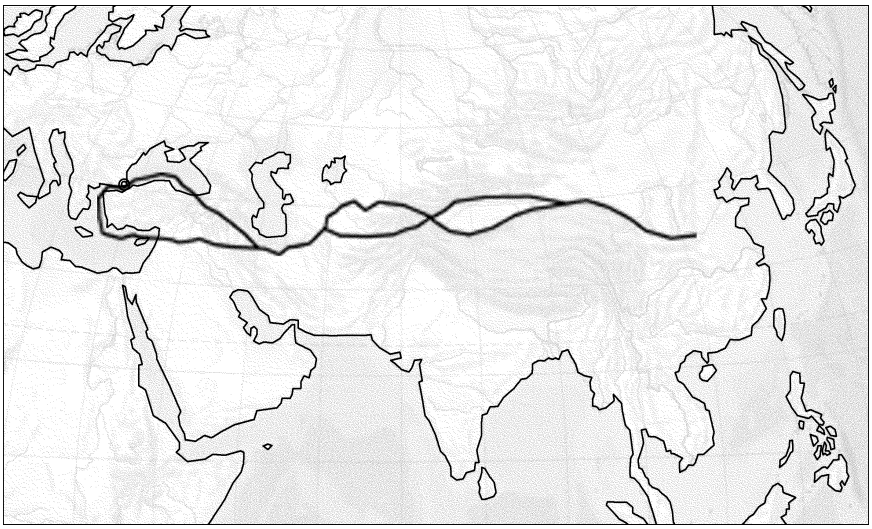


Main empires are the Byzantine Empire, the Islamic Khalifate, and the Tang Empire for most of the period in question.

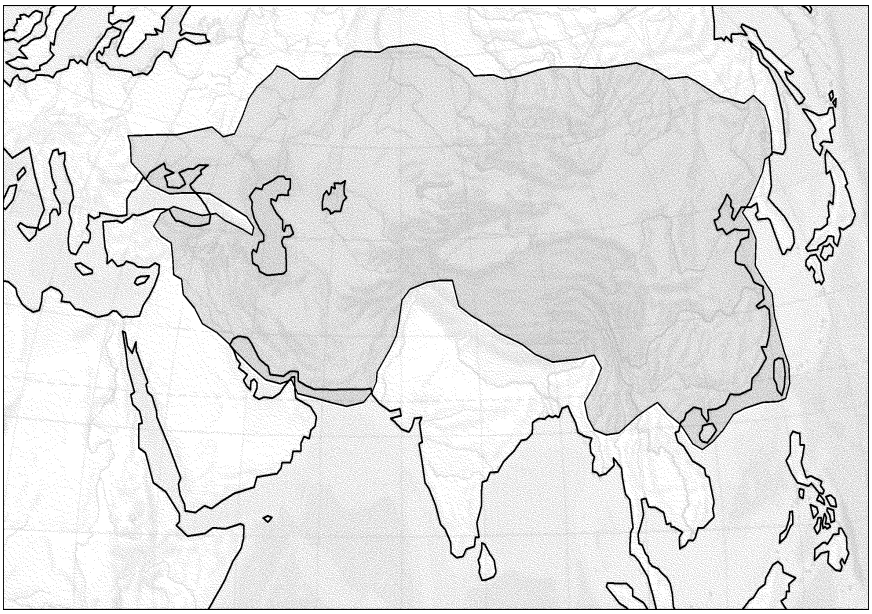
Calculation results



Main routes of The Silk Roads' System at this epoch

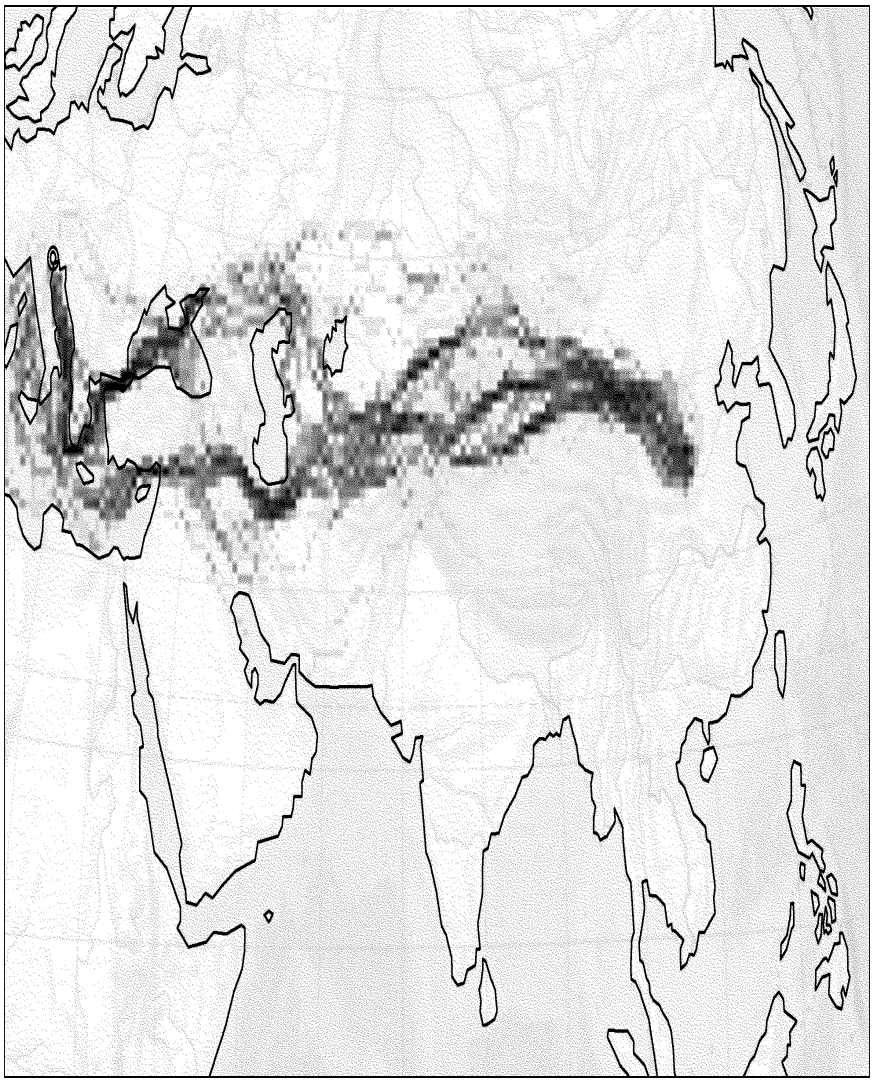


XI – XIV CE. The epoch of the Mongol Empire

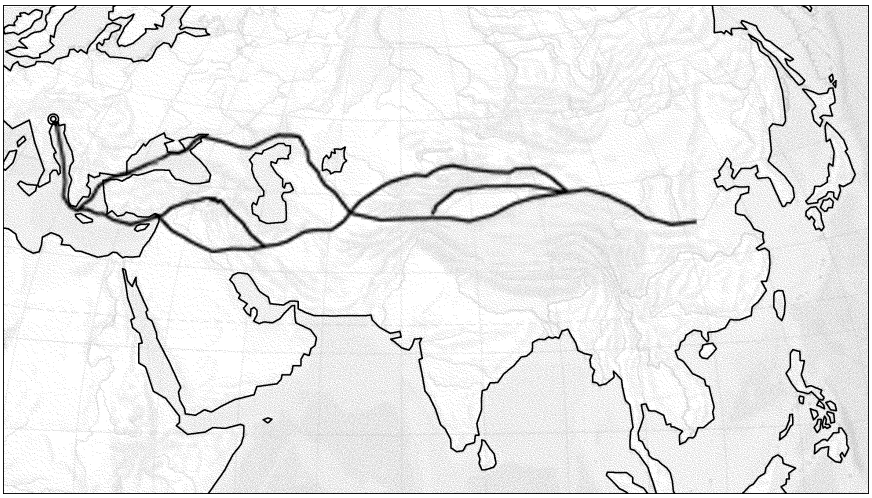


Huge Mongol empire was the main power of this epoch. It was the first time that military networks reached such a scale.

Due to activity of the Mongols a stable intensive Silk Roads route to the north of the Caspian Sea appears for the first time

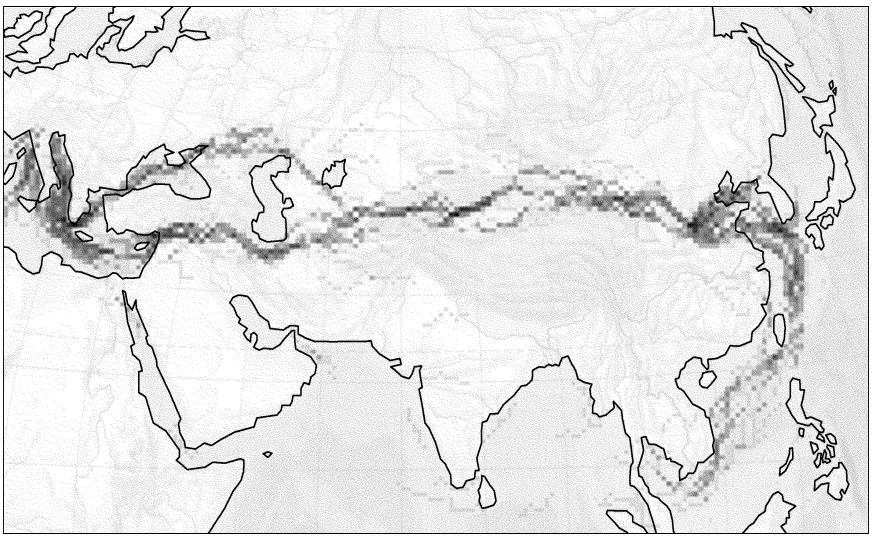


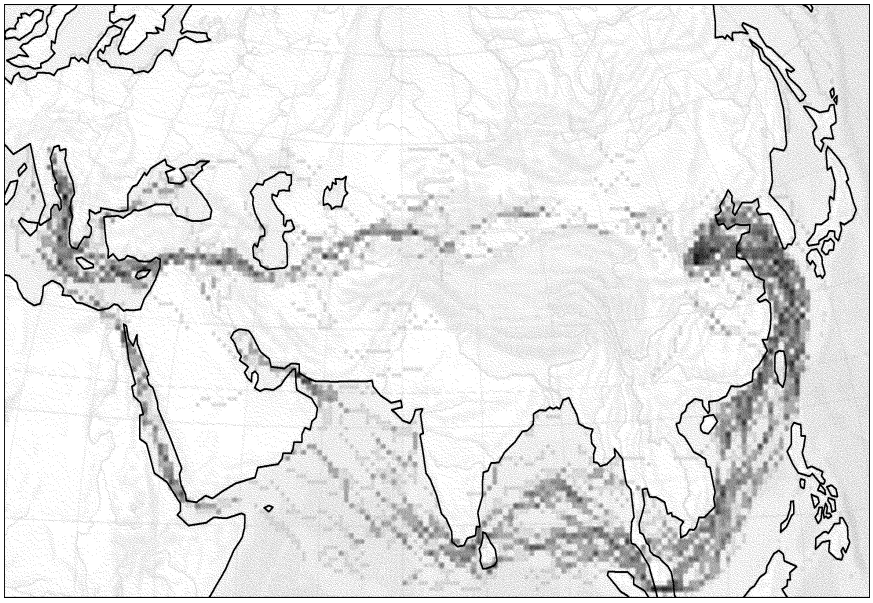
The system of main routes with Venice as a destination point in Europe

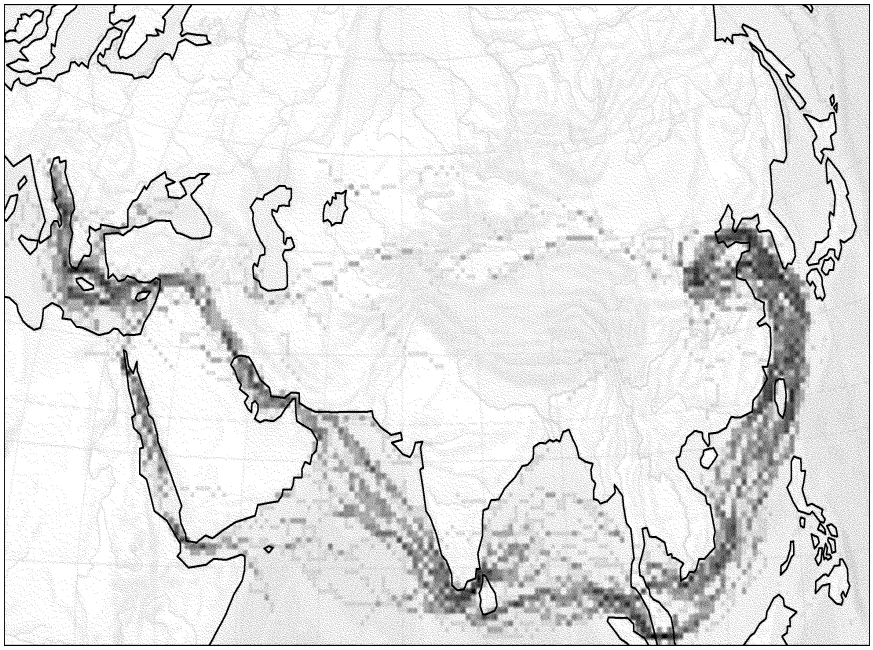


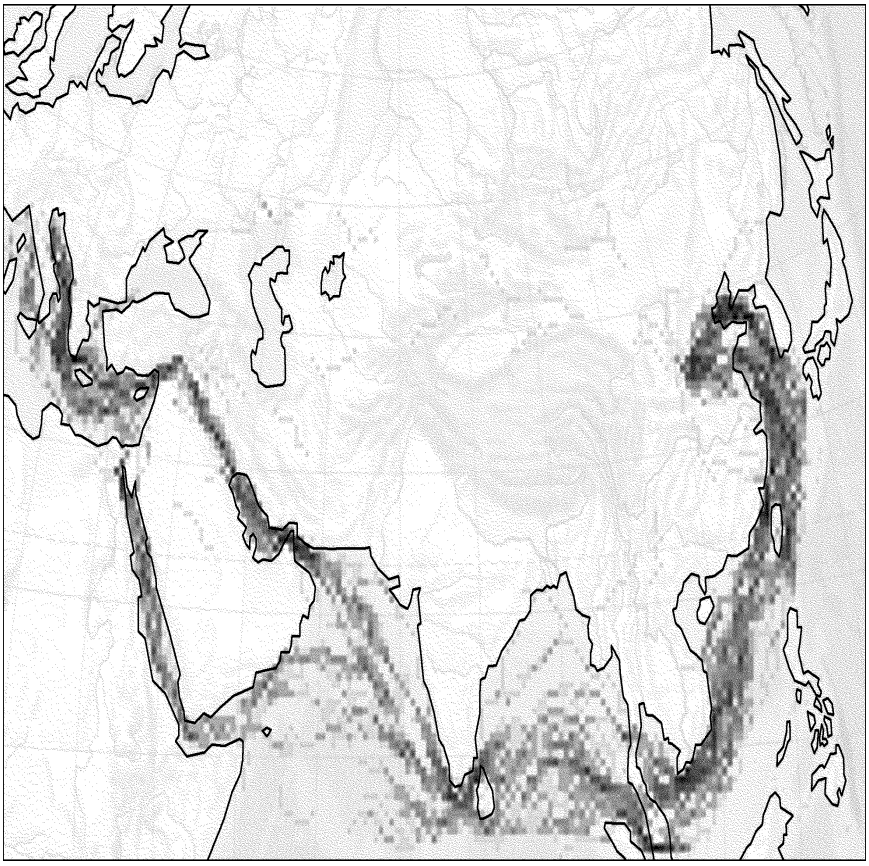
After the fall of the Mongol Empire the system of the Silk Roads demises and never retakes its former importance. The model gives a curious explanation of this fact. According to the model European galleons were the cause of this process.

If we increase the commodity-conduction of the Indian Ocean we obtain the following sequence of pictures:









This increase of inductivity can be considered (with respect to Bentley's theory) as a result of naval expansion of new European empires.

Let us say a few words in conclusion.

The obtained results look curious, but they are still too rough. We used rather simple a model that involves only one factor – the factor of large empires. It is impossible to expect precise prediction at every point as it is in physics. To adjust the results we must take into account other factors, add new equations and expand the model. However, new equations must be proposed only after successful approbation and testing.

So it is not reasonable to hurry with the model expansion. The results show that the model is valid in principle, so our further work is to apply it to more precise historical data, propose more effective methods of conductivity evaluation and try to obtain actual predictions.

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List of Contributors

Leonid Grinin is a senior research fellow of the Volgograd Center for Social Research, a vice-editor of the journals *History and Modernity* and *Philosophy and Society*, and a co-editor of the *Social Evolution & History*. Current research interests include the long-term trends in the evolution of technologies and their influences on sociocultural evolution, periodization of history, and long-term development of the political systems. He is author of over 100 scholarly publications, including such books as "Philosophy, Sociology, and Theory of History", "Productive Forces and Historical Process", "Formations and Civilizations", "The State and Historical Process". His journal articles include "The Early State and Its Analogues" (*Social Evolution & History* 1: 131–176), "Democracy and Early State" (*Social Evolution & History* 3[2]: 93–149), "Early State and Democracy" (in *The Early State, Its Alternatives and Analogues*, pp. 419–463. Volgograd: Uchitel), and "The Early State and Its Analogues: A Comparative Analysis" (in *The Early State, Its Alternatives and Analogues*, pp. 88–136. Volgograd: Uchitel). Email: LGrinin@mail.ru.

Jürgen Klüver is Professor Emeritus of Information Technologies and Educational Processes, Essen, Germany. Current research interests include the analysis of social and cognitive complex systems by computer based mathematical models, in particular the evolutionary unfolding of sociocultural complexity by ontogenetic learning processes. Jürgen Klüver is the author of a lot of books and articles. Among these are *An Essay Concerning Sociocultural Evolution. Theoretical Principles and Mathematical Models* (Dordrecht: Kluwer Academic Publishers, 2002), "The Logical Structure of Evolutionary Theories" (in *Computational and Mathematical Organization Theory* 9 [2003]), *Computerimulationen und soziale Einzelfallstudien* (Bochum-Herdecke: w3l, 2006), and *On Communication. An Interdisciplinary and Mathematical Approach* (together with Christina Klüver, Dordrecht: Springer, 2007). Email: Juergen.Kluever@Uni-Due.de.

Andrey Korotayev is Director and Professor of the "Anthropology of the East" Center, Russian State University for the Humanities, Moscow, as well as Senior Research Fellow of the Institute for Oriental Studies and the Institute for African Studies of the Russian Academy of Sciences. He is author of over 250 scholarly publications, including *Ancient Yemen* (Oxford: Oxford University Press, 1995), *Pre-Islamic Yemen* (Wiesbaden: Harrassowitz Ver-

lag, 1996), *Social Evolution* (Moscow: Nauka, 2003), *World Religions and Social Evolution of the Old World Oikumene Civilizations: a Cross-Cultural Perspective* (Lewiston, NY: Mellen, 2004), *Introduction to Social Macrodynamics: Compact Macromodels of the World System Growth.* (Moscow: URSS, 2006, with Artemy Malkov and Daria Khaltourina), *Introduction to Social Macrodynamics: Secular Cycles and Millennial Trends* (Moscow: URSS, 2006, with Artemy Malkov and Daria Khaltourina), *Introduction to Social Macrodynamics: Secular Cycles and Millennial Trends in Africa* (Moscow: URSS, 2006, with Daria Khaltourina). Email: AKorotayev@mail.ru.

Artemy Malkov is Research Fellow of the Keldysh Institute for Applied Mathematics, Russian Academy of Sciences. His research concentrates on the modeling of social and historical processes, spatial historical dynamics, genetic algorithms, cellular automata. He has authored and co-authored over 45 scholarly publications, including such monographs as *Introduction to Social Macrodynamics: Compact Macromodels of the World System Growth.* (Moscow: URSS, 2006), *Introduction to Social Macrodynamics: Secular Cycles and Millennial Trends* (Moscow: URSS, 2006), as well as such articles as "History and Mathematical Modeling" (2000), "Mathematical Modeling of Geopolitical Processes" (2002), "Mathematical Analysis of Social Structure Stability" (2004) that have been published in the leading Russian academic journals. Email: AS@Malkov.org.

Victor de Munck is an Associate Professor in the Anthropology Department of the State University of New York – New Paltz. His specialty is cognitive anthropology; he has published one monograph (*Culture, Self and Meaning*) on this subject and 15 articles on describing the dynamics between cognitive processes and culture, as well as a number of articles in cross-cultural research, including "Sexual Equality and Romantic Love: A Reanalysis of Rosenblatt's Study on the Function of Romantic Love" (*Cross-Cultural Research* 33 [1999]: 265–277, with Andrey Korotayev), "«Galton's Asset» and «Flower's Problem»: Cultural Networks and Cultural Units in Cross-Cultural Research (or, the Male Genital Mutilations and Polygyny in Cross-Cultural Perspective)" (*American Anthropologist* 105 [2003]: 353–358, with Andrey Korotayev) and "Valuing Thinness or Fatness in Women: Reevaluating the Effect of Resource Scarcity" (*Evolution and Human Behavior* 26 [2005]: 257–270, with Carol R. Ember, Melvin Ember, and Andrey Korotayev). Professor de Munck has conducted three years of fieldwork in Sri Lanka which has so far yielded one ethnography (*Seasonal Cycles*. Delhi: Asian Educational Services, 1993) and over forty articles. Most recently Dr. de Munck received grants from the National Science Foundation and the Fulbright Foundation grant. These have been used to conduct field work on

romantic love, marriage choices and sexual practices in Russia, Lithuania and the U.S. This research has thus far yielded one edited volume and a number of articles on cultural models of romantic love. Email: DeMunckV@NewPaltz.edu.

Charles S. Spencer is Curator of Mexican and Central American Archaeology in the Division of Anthropology, American Museum of Natural History, New York, NY, USA. His research focuses on the cultural evolution of complex societies in prehistory. He has conducted archaeological fieldwork in Mexico and Venezuela. He is the author of numerous articles and monographs, including *The Cuicatlán Cañada and Monte Albán: A Study of Primary State Formation* (New York, NY: Academic Press, 1982), "On the Tempo and Mode of State Formation: Neoevolutionism Reconsidered" *Journal of Anthropological Archaeology* 9 [1990]: 1–30), "War and Early State Formation in Oaxaca, Mexico" in *Proceedings of the National Academy of Sciences* (100 [2003]: 11185–11187) and, with his frequent collaborator Elsa M. Redmond, "Multilevel Selection and Political Evolution in the Valley of Oaxaca, 500–100 B.C." in *Journal of Anthropological Archaeology* (20 [2001]: 195–229), "The Chronology of Conquest: Implications of New Radiocarbon Analyses from the Cañada de Cuicatlán, Oaxaca" in *Latin American Antiquity* (12 [2001]: 182–202), "Militarism, Resistance, and Early State Development in Oaxaca, Mexico in *Social Evolution & History* (2 [2003]: 25–70), "A Late Monte Albán I Phase (300–100 B.C.) Palace in the Valley of Oaxaca" in *Latin American Antiquity* (15 [2004]: 441–455), "Primary State Formation in Mesoamerica" in *Annual Review of Anthropology* (33 [2004]: 173–199), "Institutional Development in Late Formative Oaxaca: The View from San Martín Tilcajete" in *New Perspectives on Formative Mesoamerican Cultures* (Oxford, UK: Archaeopress, 2005), and "Resistance Strategies and Early State Formation in Oaxaca, Mexico" in *Intermediate Elites in Precolumbian States and Empires* (Tucson: University of Arizona Press, 2006). Email: CSpencer@AMNH.org.

Peter Turchin is Professor of Ecology and Evolutionary Biology, University of Connecticut, Storrs, CT, USA. Current research interests include human population dynamics (secular and bigenerational cycles); long-term oscillations in economic and social structures of agrarian societies, and the evolution of human ultrasociality. Peter Turchin is the author of four books, including *Complex Population Dynamics: A Theoretical/Empirical Synthesis* (Princeton, NJ: Princeton University Press, 2003), *Historical Dynamics: Why States Rise and Fall* (Princeton, NJ: Princeton University Press, 2003) and *War and Peace and War: Life Cycles of Imperial Nations* (New York, NY: Pi Press, 2005) and more than 100 scientific articles, including "Dy-

namical Feedbacks between Population Growth and Sociopolitical Instability in Agrarian States" (*Structure and Dynamics* 1 [2005]) and Population Density and Warfare: A Reconsideration (*Social Evolution & History* 5 [2006], with Andrey Korotayev). Email: Peter.Turchin@UConn.edu.