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Modeling Social Pressures Toward Political Instability

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Structural-demographic theory is a conceptual tool for understanding and explaining long-term social pressures that can lead to revolutions, civil wars, and other major outbreaks of socio-political instability. This article develops a general modeling framework for quantifying such structural pressures toward instability. Following the basic premises of the structural-demographic theory, the approach adopted here decomposes pressures toward instability into three components, dealing with the general population, elites, and the state, respectively. Several feedback loops affecting the dynamics of these components are modeled explicitly, including the effect of labor oversupply on real wages and on elite overproduction. I apply the modeling framework to two empirical case studies: investigating structural-demographic dynamics during the nineteenth century (with a focus on the period preceding the American Civil War) and during the twentieth century (with a focus on the contemporary period).

Introduction

In *Revolution and Rebellion in the Early Modern World* Jack Goldstone wrote that the causes of revolutions and major rebellions are in many ways similar to processes that cause earthquakes (Goldstone 1991: 35). In both revolutions and earthquakes it is useful to distinguish the structural conditions (pressures, which build up slowly) from triggers (sudden releasing events, which immediately precede a social or geological eruption).

Specific triggers of political upheavals, such as the self-immolation of a fruit vendor, which triggered the Arabic Spring in Tunisia, are very hard, perhaps impossible, to predict. On the other hand, structural pressures build up slowly and predictably, and are amenable to analysis and forecasting. Furthermore, many triggering events themselves are ultimately caused by pent-up social pressures that seek an outlet—in other words, by structural factors.

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Structural-demographic theory was developed by Goldstone and others (Nefedov 2003, Turchin 2003b, Korotayev et al. 2011) as a tool for understanding long-term social pressures that lead to revolutions, civil wars, and other major outbreaks of socio-political instability. The theory represents complex human societies as systems with three main compartments (the general population, the elites, and the state) interacting with each other and with socio-political instability built in via a web of nonlinear feedbacks (Figure 1). The focus on only these four structural components is not quite as oversimplified as it may appear, because each component has a number of attributes that change dynamically in response to changes in other structural-demographic variables.

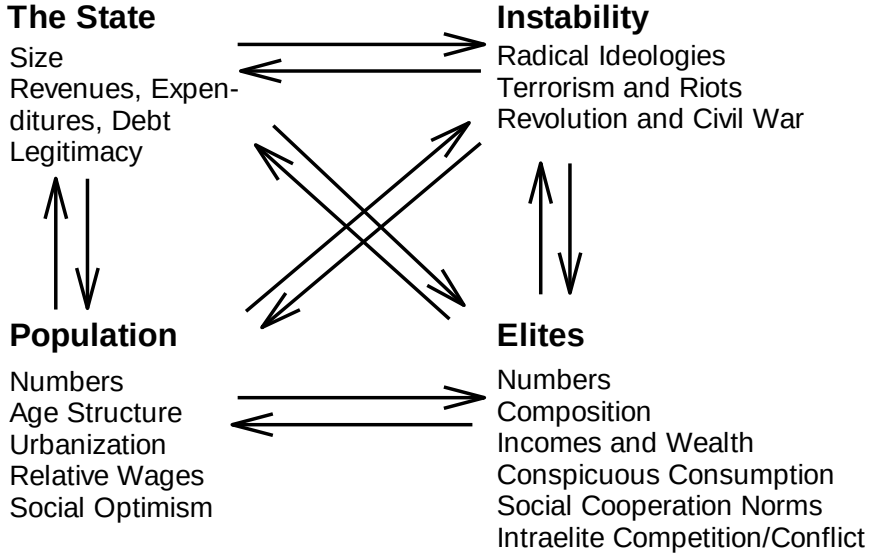

Figure 1. The main logical components of the structural-demographic theory.

The dynamics of population *numbers* (italics indicate various attributes listed in Figure 1), for example, are affected by other attributes of the general population, such as incomes and consumption levels. Higher consumption levels and some other factors, such as *social optimism*, have a positive effect on population growth (when they are high, people tend to marry earlier and have more children). On the other hand, sociopolitical instability (especially in its extreme forms, such as civil war, which results in elevated death rates and depressed birth rates) acts to depress population growth.

Age structure is affected by fluctuations in the population growth rate. Thus, a sudden release from the 'Malthusian Trap,' occurring as part of

modernization processes, may generate a period of very rapid population growth that, after a time lag of 20–25 years, results in what is known as 'youth bulges'—unusually large cohorts of youths aged in their twenties (Korotayev et al. 2011). Youth bulges tend to be politically destabilizing, because a sudden increase of new worker entry into the labor force tends to depress their employment prospects and wages (Easterlin 1980, Macunovich 2002). Furthermore, young adults in the 20–29 age cohort are particularly susceptible to radicalization. Both of these processes contribute to the mobilization potential of the population (Goldstone 1991).

Urbanization dynamics is in many ways similar to age structure. Rapid population growth in rural areas creates a 'population surplus,' potential workers who can find no employment in the villages and are forced to migrate to cities, where they are concentrated in a structural setting that facilitates collective action (Goldstone 1991). Thus, rapid population growth in excess of employment opportunities can lead to declining standards of living, appearance of a youth bulge, and rapid urbanization—all processes that increase the mobilization potential of the population and thus are inherently destabilizing.

Relative wages are wages scaled by GDP per capita. This quantity is similar to the 'labor share of income,' used in economics, which measures the proportion of total economic production that is paid out as wages. However, while economists are interested in how the fruits of economic growth are divided between labor and capital, our primary interest is in how it is divided between commoners and elites. The problem with the labor share of income is that it includes multi-million dollar salaries paid out to CEOs, corporate lawyers, and other high-earning individuals who are definitely members of the elite. Even though there are few such individuals, they earn hundreds, or even thousands, of times as much as a typical (median) wage earner. Thus, to obtain a measure that is more relevant to the share of economic growth going to commoners, we need to scale the *median* wage by GDP per capita (instead of scaling the *mean* wage, which is what labor share effectively does). Because data on median wages are available only for the more recent decades, I use data on production workers compensation (Officer and Williamson 2013).

Turning now to the various attributes of the elite compartment (Figure 1), the first and most important one is their *numbers*. Elite numbers are affected by two general processes. One is simply demography, the balance of births and deaths, the same mechanism that governs the dynamics of general population numbers. Second, elite numbers can change as a result of social mobility. One of the most important factors affecting social mobility is the oversupply of labor, which creates a favorable economic conjuncture for intelligent, hard-working, or simply lucky commoners to accumulate wealth and then translate it into elite status.

Elite *composition* refers to the relative numbers of established elites (those who have inherited their wealth and social status) and new elites (who moved into the upper class by their own efforts). it also includes aspirant elites (individuals aspiring to elite status by virtue of their newly acquired wealth or educational credentials; this category also includes second sons, etc., of established elite families who are in danger of losing elite status) and counter-elites (radicalized aspirant elites, whose aspirations to secure an elite position/status have been frustrated).

Elite *incomes* are affected by the economic conjuncture (depressed real wages for commoners translate into increased revenues for the elites), elite numbers (greater numbers result in a smaller average slice of the total economic pie), and by state expenditures (since the state is the source of many elite positions). *Wealth* is another important attribute because it is closely related to power (most directly, it is the economic form of power, but it can also be translated into political and ideological forms). Wealth is often a better indicator of the economic status of the elites, because it tends to fluctuate less on an annual basis. Additionally, "wealth gives a better picture of differences in access to resources" (Stiglitz 2012: 2).

Elite overproduction, the presence of more elites and elite aspirants than the society can provide positions for, is inherently destabilizing. It reduces average elite incomes and increases *intraelite competition/conflict* because of large numbers of elite aspirants and, especially, counter-elites. Additionally, intraelite competition drives up *conspicuous consumption*, which has an effect of inflating the level of income that is deemed to be necessary to maintain elite status. Internal competition also plays a role in the unraveling of *social cooperation norms*.

The preceding discussion of population and elite compartments highlights three important classes of their attributes: some measure of size or numbers, the economic aspects, and cultural or ideological aspects. The state compartment similarly is characterized by its *size* (e.g., measured by the total number of state employees or, alternatively, by the proportion of GDP going to the state), its economic health (*revenues, expenditures, debt*), and by an ideological aspect (state *legitimacy* as measured, for example, by the degree of trust in the state and national institutions).

The last compartment—instability—is somewhat different because it is a process, rather than a societal subsystem. However, it also has a 'size' aspect (the frequency of comparatively minor forms of political violence such as *terrorism and riots*; and the magnitude of more serious forms such as *revolution and civil war*, which could be measured by the number of casualties) and a cultural/ideological aspect (growth or decline of *radical ideologies*).

This overview, even if brief and focusing only on the most important interactions, nevertheless indicates the rich complexity of structural-

demographic theory. The downside of this complexity is the difficulty of translating the verbal version of the theory into mathematical language, a necessary step for testing its logical coherence (in other words, checking whether the postulated dynamical behavior indeed arises from the premises). In principle, it is possible to build a very complicated model that would attempt to capture all the interactions postulated by the verbal theory. However, experience in many scientific fields, including both natural and social sciences, shows that such a research program is self-defeating. Large complex models not only require many arbitrary decisions and the estimation of a multitude of difficult-to-measure parameters. Such models also tend to be structurally unstable, so that a small change in one parameter value results in a large change in the dynamics of the model. For this reason, the only feasible approach to dealing with such complex systems is to build a spectrum of models, each addressing a somewhat different aspect of the problem, and each simple enough so that it avoids the pitfalls of large unwieldy models. As Einstein famously said, a model should be as simple as possible, but no simpler than that.

There are two complementary approaches to building models of manageable complexity. In the first we focus on the short- and medium-term dynamics by modeling the development of a particular variable, or a particular compartment of the model. The question is, how changes in other variables contribute to the dynamics of the focal variable. Of particular interest are trend reversals: can the theory explain why sociopolitical instability, for example, declined for some decades, and then abruptly began growing? Because our focus is on a particular variable, to keep the model simple we include only those feedback loops that are critical to describing the dynamics of the focal variable. For this reason such models are 'dynamically incomplete' and are not suitable for investigating the long-term dynamics of the system. For example, an explosive growth of political violence will eventually have consequences for other compartments in the model that will work to bring it down, but we do not include such feedback effects in the model explicitly.

The second approach is to construct dynamically complete models, with the purpose of investigating long-term dynamics of the system. However, in order to be of manageable complexity, such dynamically complete models must keep the number of dynamical feedbacks that are investigated to an absolute minimum and drastically simplify how each link is modeled. Examples of such models can be found in Nefedov (2002), Turchin (2003a), Turchin and Korotayev (2006), and Korotayev et al. (2006).

In this article I focus on the first approach and develop a model whose goal it is to understand the genesis of secular instability waves. Other models, including dynamically complete ones, are dealt with in a forthcoming book (Turchin 2014). The article is organized as follows. In the next section I present a general modeling framework for quantifying structural-demographic

pressures toward instability. Next, I apply this modeling framework to two case studies, investigating structural-demographic dynamics during the nineteenth century (with a focus on the period preceding the American Civil War) and during the twentieth century (with a focus on the contemporary period).

Quantifying Social Pressures for Instability

Political Stress Indicator

One of the main goals of structural-demographic theory is to understand and predict the dynamics of sociopolitical instability. Ultimately, we are interested in explaining why, and when, states collapse, revolutions and rebellions happen, and civil wars break out. The onset of a revolution or a civil war, however, only partially depends on deep structural forces that are explicitly modeled in the theory. The timing of such events is also affected by historical contingency, accidents, and acts of human free will (for a general discussion, see Turchin 2006: Chapter 12). As was discussed in the *Introduction*, we can put these two kinds of explanations within a single theoretical framework by distinguishing between the *structural causes* of revolutions and *specific triggers* that set in motion the chain of events leading to a revolution.

In his analysis of the social causes of the English Revolution, Goldstone (1991: 141–145) proposed that we can quantify pressures for crisis with a "*P*olitical *S*tress *I*ndicator," PSI or Ψ. Here I follow the general logic of this approach, but with several modifications, particularly, of the functional forms proposed by Goldstone.

The Political Stress Indicator reflects the tri-partite representation of social systems (population-elites-the state) by integrating the sources of pressure toward instability arising from each part: Mass Mobilization Potential (MMP), Elite Mobilization Potential (EMP), and State Fiscal Distress (SFD). I assume that these three components are combined in the index multiplicatively:

$$\Psi = \mathrm{MMP} \times \mathrm{EMP} \times \mathrm{SFD}$$

Social pressures arising from popular distress are indexed with Mass Mobilization Potential (MMP), which has three subcomponents (relative wages, the urbanization rate, and the effect of age structure):

$$\mathrm{MMP} = w^{-1} \frac{N_{\mathrm{urb}}}{N} A_{20-29}$$

where w^{-1} is the inverse relative wage (related to the "misery index," see Turchin and Nefedov 2009). *Relative wage* is the wage scaled by GDP per capita. The urbanization index N_{urb}/N is the proportion of total population (N) within the cities (N_{urb}). The last term, A_{20-29}, is the proportion of the cohort

aged between 20 and 29 years in the total population. This quantity reflects the role of 'youth bulges' in the genesis of instability waves.

I use a similar approach to quantify the second component of Ψ, which deals with the elite overproduction and competition:

$$\mathrm{EMP} = \varepsilon^{-1} \frac{E}{sN}$$

When dealing with the elites, I omit the effect of youth cohorts, primarily because it is undesirable to include this quantity twice in Ψ (it is already incorporated into MMP). The first term on the right hand side, ε^{-1}, is the inverse relative elite income (average elite income scaled by GDP per capita), which is analogous to w^{-1} of the working population. The second term measures the effect of intraelite competition for government offices. It assumes that the number of positions will grow in proportion to the total population (N). The proportionality parameter s is the number of government employees per total population (which is allowed to change dynamically). Thus, EMP combines two potential sources of intraelite competition: economic and political. If s is a constant, then the formula for the Elite Mobilization Potential simplifies to EMP = ε^{-1} e, where relative elite numbers $e = E/N$ (and the proportionality constant is dropped, because we are only interested in relative changes of PSI components with time, rather than the absolute level around which they fluctuate).

The third component of Ψ, State Fiscal Distress, has two parts. One is a measure of national debt scaled in relation to the GDP. The second part measures the degree of trust (or, rather, distrust) that the population and elites have in the state institutions (a proxy for the state legitimacy). The formula for SFD is thus:

$$\mathrm{SFD} = \frac{Y}{G} D$$

where Y is the total state debt, G is the GDP, and D is a measure of public distrust in the state.

The various building blocks of Ψ usually do not develop independently of each other. In particular, structural-demographic variables reflecting attributes of general well-being and elite dynamics are interconnected by a series of feedback loops. In the next section I construct a mathematical model that attempts to capture these feedback loops and the resulting dynamics.

The Dynamics of Real Wages

I begin building the model with a focus on the economic aspect of popular well-being—primarily, real wages (inflation-adjusted wages). The general modeling approach that I will use is fairly standard in macroeconomics (e.g., Blanchard 1997:305ff). The main factor under consideration is typically the relationship

between wages and unemployment or, alternatively, the balance of labor supply and demand (Blanchard 1997:310). However, to this purely economic model I add a component that reflects the action of extra-economic (non-market) forces. Such an approach yields a more general model, which can be used not only to model wages and levels of consumption in free-market societies, but in more general settings. The model developed below is similar in spirit to the regression model used by Dani Rodrik to investigate the effect of democracy on wages (Rodrik 1999).

The starting point for building a model for the dynamics of real wages is GDP (gross domestic product) per capita. This quantity is often, and somewhat misleadingly, referred to as 'per capita income.' As a result of industrialization, the real GDP per capita often increases by an order of magnitude and it stands to reason that such a huge increase in the economic productivity should have an effect on how much individual workers earn. However, as we shall see later, trends in real wages can diverge substantially from the per capita GDP trend (this happens in a cyclic manner reflecting different phases of secular waves).

There are two broad explanations for why increasing GDP does not necessarily translate into wage growth. The first one reflects the operation of market forces. The economic mechanism is the law of supply and demand, which states that when the supply of labor (S) exceeds demand for it (D), the price of labor (that is, real wage) should decrease. Thus, real wage W is a function not only of GDP per capita, G/N (where G is GDP and N is the total population), but also of the balance of demand and supply, D/S.

The additional factors affecting real wage dynamics are non-market or 'extra-economic' forces. They reflect the operation of three non-economic sources of social power: coercive, political, and ideological. Coercive and political factors (power relations) often operate synergistically with ideological factors (prevailing social norms and institutions), so for simplicity I fold them into a single variable, C (standing for 'culture' or alternatively 'coercion', depending on the modeling context).

The general model of real wages, W, takes the following form:

$$W_{t+\tau} = a\left(\frac{G_t}{N_t}\right)^{\alpha}\left(\frac{D_t}{S_t}\right)^{\beta} C_t^{\gamma} \quad (1)$$

The subscripts index time (years). The three main components, GDP per capita, demand/supply ratio, and culture are combined in an admittedly phenomenological fashion. The reason for using this form is apparent when we take logarithms ($A = \log a$):

$$(2) \qquad \log W_{t+\tau} = A + \alpha \log\left(\frac{G_t}{N_t}\right) + \beta \log\left(\frac{D_t}{S_t}\right) + \gamma \log C_t + \varepsilon_t$$

which recasts the model in the form suitable for regression analyses. Note the addition of the error term, ε_t (which may include autocorrelation and moving average components). This functional form implies that the influences of the three factors on log-transformed wage are combined linearly and additively—in other words, this is the simplest possible model to use. Log-transforming W makes sense on both theoretical and statistical grounds. The theoretical motivation is explained in Turchin (2003a: Chapter 2). Briefly, the null model for many growth processes, including economic growth, is the exponential law. As a result, if one wants to linearize the outcome of growth and investigate factors that influence it, one needs to take logarithms. Log-transformation of the dependent variable also tends to stabilize variance, which is a plus in regression analyses. In short, if we do not have a functional form that arises from an explicitly mechanistic theory, the form (1) is the way to go. This accounts for its popularity in biological and economic applications (in economics, for example, the Cobb-Douglas function is a special case of this form).

Exponents α, β, and γ (the regression coefficients in the linearized form) measure relative contributions of the three factors to the growth of real wage. The parameter $A = \log a$ has no interpretation; it simply is a reflection of how independent variables are scaled. The final parameter, τ, which appears in the subscript of W, measures the degree of 'stickiness' of wages. Changing conditions, as reflected especially in D/S and C factors, will shift the equilibrium to which W will start moving. However, W is an inertial variable and it takes several years for it to equilibrate. I model this lagged response phenomenologically with τ. The lag τ should be at least 3 years (typical length of contracts negotiated between management and unions) and probably no longer than 10 years, but the best value for this parameter will need to be determined empirically.

Model (1) is a general formulation. Its specific form will vary depending on the economic relations characterizing the studied society. For example, in countries with command economies, such as the USSR at its height, the forces of labor supply and demand (the D/S ratio) will have no effect on wages. The general model simplifies to

$$W_t = C_t\left(\frac{G_t}{N_t}\right)$$

where C_t reflects the decisions of central planners on what proportion of the GDP to devote to personal consumption, as opposed to capital investment and

to the state (see Allen 2003 for a history of the Soviet industrialization as an example).

In economies based on slavery, the equation is even more simplified, $W_t = C_t$. In other words, the consumption levels of slaves are set by their owners, who take into consideration such factors as how much they need to spend on maintaining their property in working condition. The G/N ratio has no effect because there is no expectation that slaves will share the fruits of a growing economy. However, the balance of supply versus demand for slaves may have an indirect effect. If supply is deficient, slave owners may decide to spend more on their working force to reduce mortality and increase reproduction (which would require adding back the D/S component).

An alternative simplification of the model omits the term involving extra-economic forces and focuses entirely on labor supply/demand dynamics:

$$W_{t+\tau} = a\left(\frac{G_t}{N_t}\right)^{\alpha}\left(\frac{D_t}{S_t}\right)^{\beta}$$

Such a formulation is appropriate for 'pure' capitalist systems. I will use it in the next section, because the economic system of nineteenth century America provides a good approximation to such a pure market-driven system. In the twentieth century, however, cultural factors played an increasingly important role (sometimes driving wages above the level set by economic forces, and at other times below this level) and will need to be estimated. Further elaborations of the modeling framework are, thus, deferred to the following sections.

Elite Dynamics

Elite numbers, E, can change as a result of two processes: endogenous population growth (the balance between births and deaths among the elite) and social mobility (from and to the general population, N). Accordingly, the equation for E is

$$\dot{E} = rE + \mu N \tag{3}$$

where r is per capita rate of population growth and μ is the coefficient capturing the balance of upward and downward social mobility between the general population compartment and the elite compartment of the model.

The rate of net social mobility, μ, should be *inversely* related to the relative wage (wage scaled by GDP per capita, $g = G/N$), because if wages do not keep up with economic growth, the elites dispose of an increasingly large amount of surplus. A favorable economic conjuncture for employers, thus, creates more opportunities for upward mobility for entrepreneurial commoners. I assume that

$$\mu = \mu_0 \left(\frac{w_0}{w} - 1 \right)$$

where w is the relative wage ($w = W/g$) and μ_0 and w_0 are scaling parameters. Parameter μ_0 modulates the magnitude of response in social mobility to the availability of surplus. Parameter w_0 is the level at which there is no net upward mobility (when $w = w_0$, $\mu = 0$). The more w falls below that level, the more positive the term on the right hand side will be, and the more vigorous upward social mobility. Conversely, when w increases above w_0, upward social mobility is choked off, and the net mobility is downwards (out of the elite compartment into the general population).

Combining these two equations, we have the following model for the dynamics of elite numbers:

(4) $$\dot{E} = rE + \mu_0 \left(\frac{w_0 - w}{w} \right) N$$

If the population growth rate of the elites is the same as that characterizing the general population, then this equation can be simplified by focusing on *relative elite numbers*, $e = E/N$. After some algebra we have

$$\dot{e} = \mu_0 \frac{w_0 - w}{w}$$

In other words, the rate of change of relative elite numbers is simply the net rate of social mobility (assuming that in modern times the elites do not differ in their demography from commoners).

The final component in the model is a calculation of how the average elite incomes change with time. I will assume that the elites divide among themselves the amount of surplus produced by the economy. This surplus is $G - WL$, where G is the total GDP (in inflation adjusted dollars), W is the real wage, and L is the size of labor force. This formulation assumes that the total economic output is divided among the elites and commoners with little or no role of the state. It is a reasonable approximation for nineteenth century America, when the economic footprint of the state was quite insignificant (a few percentage points of the GDP). However, for the twentieth century a more elaborate approach is required, which tracks the state and private sectors separately.

Dividing this quantity by the elite numbers (E) we obtain average surplus per elite. Finally, we scale average surplus per elite by the GDP per capita, or *relative elite income*:

$$\varepsilon = \frac{1}{g} \frac{G - WL}{E}$$

which simplifies to

$$\varepsilon = \frac{1 - w\lambda}{e} \tag{5}$$

where w is the relative wage of workers (scaled by GDP per capita), e is relative elite numbers (elites as a proportion of the total population), and $\lambda = L/N$ proportion of the total population that is employed. Because the total population includes children and the elderly, $\lambda \approx 0.5$. This parameter can fluctuate as a result of greater or lesser labor force participation and due to changes in the unemployment rate, but generally speaking such fluctuations stay within fairly narrow bounds, so the dynamics of ε are mostly determined by w and e.

Equations 1–5 describe the general model of worker-elite interactions, which will serve as the basis for more specific models in the following sections, dealing with social pressures for instability during the nineteenth and twentieth centuries, respectively.

Structural-Demographic Dynamics in the Antebellum Period

I now apply the general framework, developed in the previous section, to the Antebellum Period of American history (the period preceding the outbreak of the American Civil War). I adapt this general framework to the specific conditions of the Antebellum United States, first focusing on demography and well-being, next on elite dynamics. Once I have modeled demography and the elites, I put these two components together using the PSI approach, and consider whether the model helps us explain the rising tide of sociopolitical instability that culminated in the American Civil War. My focus is on the Northern section, because the main structural-demographic pressures toward instability were generated there (while the South played more a defensive role).

Demography and Wages

The first component of the model is demographic growth. I assume that population is divided among two 'compartments:' the rural and urban. This is meant to approximate the situation in the Northeastern states (specifically, I focus on the four populous states of the Eastern seaboard: Massachusetts, Connecticut, New York, and New Jersey). For simplicity, I ignore migratory fluxes: the arrival of immigrants from Europe and emigration to Western states (I investigated a more elaborate model that takes such flows into the account and found that it produces qualitatively similar results; this will be discussed below). The starting point for modeling the dynamics of rural population, N, is the exponential equation (Turchin 2003a):

$$\dot{N}_{\text{rur}} = rN_{\text{rur}}$$

where r is the per capita rate of population growth and the dot over N indicates a time derivative (alternatively written as dN/dt). Between 1780 and 1860, the per capita rate of growth of the American population declined from 3 to 2 percent per year, so I will set $r = 2.5$.

Naturally, rural population cannot grow without bound. There is a certain rural *carrying capacity, K*, determined by the availability of agricultural land. For example, for the four Northeastern states (MA, CT, NY, and NJ) a reasonable estimate of K is 3.5 million (because that is the level at which the rural population equilibrated in the second half of the nineteenth century, see Figure 2 below). As rural population approaches its carrying capacity, there will be an increasing dearth of land, which will trigger emigration flows to the cities. I will assume that the migration rate is

$$M = r_{\text{rur}}\left(\frac{N_{\text{rur}}}{K}\right)^{\theta}$$

If the exponent $\theta = 1$, then the migration rate increases linearly with N and approaches r as N approaches K. In other words, when rural population reaches its carrying capacity, all 'surplus' people produced by population growth immediately migrate to the cities. The assumption of linearity, however, is not a very realistic one, because migration rate should be close to zero as long as N is low, and then accelerate as N approaches K. The exponent θ allows us to capture this nonlinearity. I set $\theta = 5$ as a reasonable compromise between 1 (linear emigration) and 10 and higher (which approximates a step function). Putting these assumptions together, we obtain the equation governing the dynamics of N:

$$\dot{N}_{\text{rur}} = r_{\text{rur}}N_{\text{rur}} - MN_{\text{rur}} = r_{\text{rur}}N_{\text{rur}} - r_{\text{rur}}N_{\text{rur}}\left(\frac{N_{\text{rur}}}{K}\right)^{\theta} \tag{6}$$

Thus, the dynamics of rural population are governed by a balance between population growth and emigration. Eqn. 6 is similar to the standard logistic model, except it introduces additional nonlinearity with the parameter θ.

The dynamics of urban population, N_{urb}, is modeled analogously:

$$\dot{N}_{\text{urb}} = r_{\text{urb}}N_{\text{urb}} + r_{\text{rur}}N_{\text{rur}}\left(\frac{N_{\text{rur}}}{K}\right)^{\theta} \tag{7}$$

where the new parameter $r_{\text{urb}} = 1.5$ percent per year is the endogenous growth rate of urban population, set to a lower value than r_{rur} to reflect increased mortality and decreased fertility rates in the cities. The second term is the immigration flow from the countryside. If we wished to make the model more

realistic, it would be desirable to add other terms reflecting immigration from overseas and emigration to the West. However, at this stage I will keep the model simple (and, as we shall see below, these two flows balanced each other out).

Setting initial conditions (for the year 1790) for populations in the two compartments as $N_{rur}(1790) = 0.3K$ and $N_{urb}(1790) = 0.1N_{rur}$ (this approximates the initial rural and urban populations in the four Northeastern states), generates the trajectories depicted in Figure 2a. Comparing them to the data on rural and urban population in the four states in Figure 2b, we observe that there is a good degree of correspondence between the model and data. This is not surprising, since certain features of the data were used in estimating model parameters; it is just a check that the model generates reasonable dynamics for population numbers. On the other hand, the model greatly simplifies the actual dynamics. Most importantly, it does not take into account immigration from Europe and emigration to the West. Additionally it simplifies endogenous population growth by assuming constant per capita rates of population increase. It appears that for the period before 1880 these simplifying assumptions largely cancel each other out, since the overall dynamics of N_{urb} and N_{rur} are close to the observed trajectories.

The next step is to model the dynamics of urban wages. I will assume that there is a demand for labor, D, which grows exponentially at a rate ρ. I assume that demand for labor grew faster than the natural rate of growth of the urban population, providing a powerful incentive for the bourgeoisie to encourage immigration. Thus, in the absence of immigration from overseas the wages of American workers would have kept pace with the growth of the GDP. On the other hand, D grew slowly enough so that, taken together, endogenous population growth and immigration outpaced it (which is why we observe falling relative wages and declining health indices). Thus, the value of this parameter should be between 2.5 and 3.5 percent per annum, or roughly $\rho = 3$. The equation for the demand for labor is simply

$$\dot{D} = \rho D \tag{8}$$

The model for the dynamics of urban wages is a simplified version of Eqn. 1:

$$W = ag\left(\frac{D}{S}\right)^{\beta} \tag{9}$$

This equation says that urban wages reflect the balance between the supply and demand. When demand (D) outpaces supply (S), wages should increase; and if the reverse is true, wages should decline. Labor supply is simply modeled as a constant proportion of the urban population, $S = \lambda N_{urb}$. Additionally, increasing GDP per capita ($g = G/N$ where N is the sum of rural

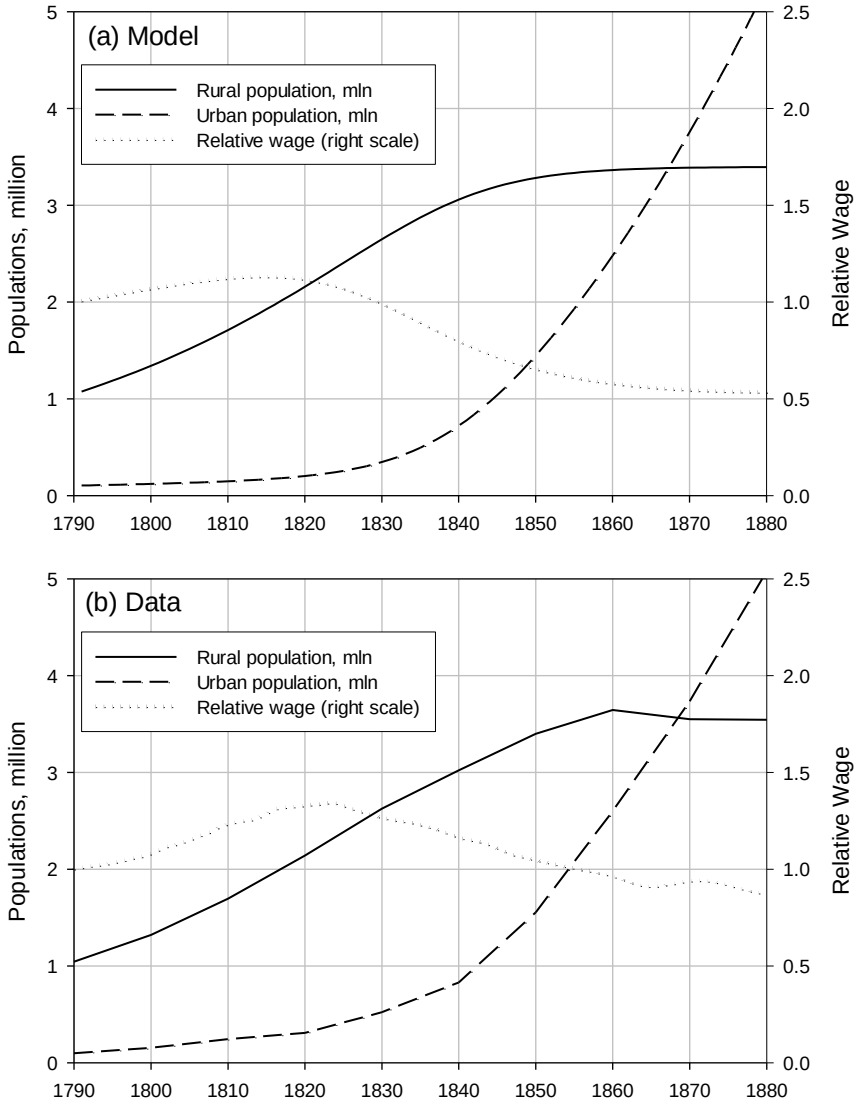

Figure 2. Population dynamics (a) generated by the model and (b) observed in the four Northeastern states (MA, CT, NY, and NJ). Data sources: calculations by the author and the *HSUS* (Carter et al. 2004). Model parameters assumed in calculations: $r_{rur} = 0.025$ y^{-1}, $r_{urb} = 0.015$ y^{-1}, $K = 3.5$ million, $\theta = 5$, $\beta = 0.5$, $a = 1$, $\rho = 0.03$ y^{-1}, $\gamma = 0.01$ y^{-1}**.**

and urban populations) should cause wages to trend upwards. I assume that GDP per capita grows exponentially at the rate of $\gamma = 1$ percent per year, which approximates the observed rate of growth of real GDP per capita between 1790 and 1870. Note that Eqn. (9) excludes extraeconomic, 'cultural' factors (C in 1), because I assume that labor-management relations in the nineteenth-century US approximated a 'pure' capitalist system (I have also simplified the model by setting parameter α, the exponent associated with g, to 1). I focus on the relative wage (scaled by GDP per capita), $w = W/g$, which is the way economic well-being enters into *PSI*. As a result, we have the following simple model:

$$w = a\left(\frac{D}{\lambda N_{\text{urb}}}\right)^{\beta} \tag{10}$$

Plotting the dynamics of the predicted relative wage, it can be observed that w exhibits nonlinear dynamics: rise until about 1820 followed by decline (the dotted line in Figure 2a). This is similar to what the observed relative wage did (Figure 2b, dotted line). At the beginning of the simulation, the growth of demand for labor in the cities outpaces the sum of endogenous growth of the urban population together with immigration from rural places. Around 1820, however, the rural population approached close enough to its ceiling to generate an increasing flow of migrants to cities that, when combined with endogenous population growth there, exceeded the capacity of the growing economy to absorb them. This shift in the D/N_{urb} balance results in the trend-reversal experienced by w.

Elite Dynamics

Elite numbers, E, grow as a result of endogenous population growth and due to upward mobility from the urban population, N_{urb} (I assume that the main avenue of upward mobility was urban artisans turning themselves into successful manufacturers). Accordingly, the equation for E is

$$\dot{E} = r_{\text{e}}E + \mu_0\left(\frac{w_0}{w} - 1\right)N_{\text{urb}} \tag{11}$$

The rate of natural population growth for the elites, r_{e}, was set to the value for rural population, on the assumption that better nutrition and ability to escape the city in summer counteracted the negative effects of urban life on elite demographic rates. The second term in Eqn. 11 reflects the rate at which urban commoners move into the elites (see previous section).

The last ingredient we need for the calculation of EMP is how the average elite incomes change with time. This part of the model follows the general theoretical framework without modification. In particular, I use Equation 5 to calculate relative elite incomes:

$$\varepsilon = \frac{1 - w\lambda}{e} \tag{12}$$

I multiply this quantity by GDP per capita to obtain real incomes.

Equations 6–12 describe the complete model. The elite dynamics predicted by the model are shown in Figure 3. At the beginning of the simulation it is assumed that the elites constitute one percent of the urban populations. Initially there is little change in this parameter. In fact, the elites lose ground slightly during the 1830s as a result of rapid growth of the urban population due to immigration from the countryside. After 1840, however, the economic conjuncture moves decisively in favor of the elites, causing massive upward mobility into the elite ranks. As a result, the proportion of elites among the general population rapidly grew to two percent by 1860 and three percent by 1870 (the solid curve in Figure 3). In absolute numbers this growth is even more remarkable: between 1840 and 1870 the elite numbers roughly triple every decade.

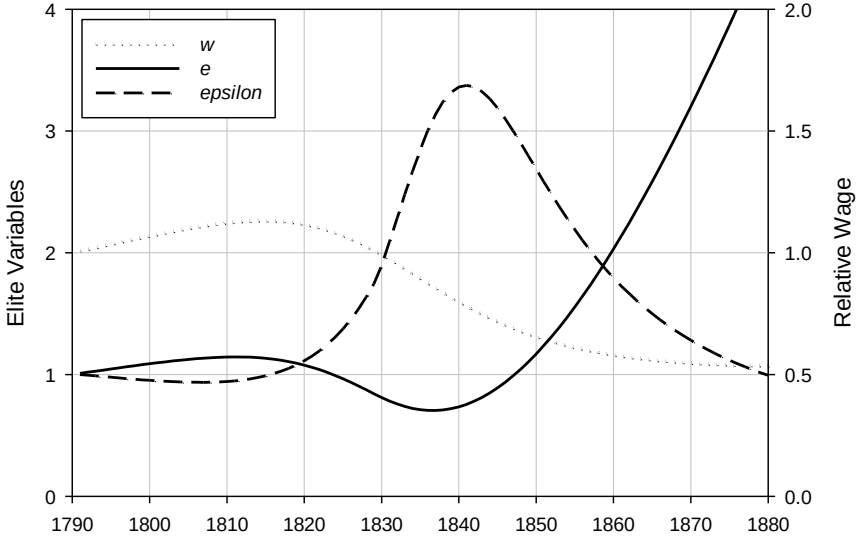

Figure 3. Elite dynamics in the Antebellum model in relation to relative wages (w): elite numbers relative to the urban population (e) and average elite incomes (ε). Parameter values: same as given in the caption of Figure 2, plus $\mu_0 = 0.002$ y^{-1}, $w_0 = 1$.

The average elite incomes (broken curve in Figure 3) stay roughly constant until 1820, and then begin to increase, due to the highly favorable economic conjuncture for the elites. However, after elite numbers climb, starting in 1840,

the average income begins to be diluted. This happens because the amount of surplus increases less rapidly than elite numbers. It is important to note that declining average income does not mean that incomes of all elite segments are decreasing. On the contrary, as intraelite competition heats up, a few will garner an increasing share of rewards, while large segments of the elites fall further and further behind. Thus, during this period we expect to see *top* incomes to continue their triumphant march upwards (which is what happened in the US after 1840).

Quantifying Social Pressures toward Instability

Modeling results in the previous two sections suggest that social pressures, both on the part of general population and the elites, were building up during the Antebellum period. The next step is to quantify the magnitude of the social forces using the PSI framework. Because the state played a minor role in the crisis of the nineteenth-century US (in particular, there was no state fiscal crisis), I focus on the first two. (Technically this means that I set the state component to a constant value. Because we are interested in relative fluctuations in Ψ, multiplying it by a constant has no effect.)

Social pressures arising from popular distress are indexed with Mass Mobilization Potential (MMP), which has three subcomponents (wages, urbanization, and age structure):

$$\mathrm{MMP} = w^{-1} \frac{N_{\mathrm{urb}}}{N} A_{20-29}$$

where the first term, w^{-1}, is the inverse relative wage, the second term is the proportion of population within the cities, and the last term, A_{20-29}, is the proportion of the cohort aged between 20 and 29 years in the total population. Recollect that this parameter measures the role of 'youth bulges'—the effect of the size of the youth cohorts on instability. Age structure was not explicitly modeled in the Antebellum model. Furthermore, because it made the simplifying assumption that birth rates did not vary with time, the implied age structure is constant, and there can be no youth bulges. Rather than complicate the model further, I will simply use the empirical information to estimate this parameter (Figure 4).

The formula for the second component of Ψ, which deals with the elite overproduction and competition, or Elite Mobilization Potential, is

$$\mathrm{EMP} = \varepsilon^{-1} \frac{E}{sN}$$

The first term on the right hand side, ε^{-1}, is the inverse of the relative elite income, and the second term measures the effect of intraelite competition for government offices. It assumes that the number of positions will grow in

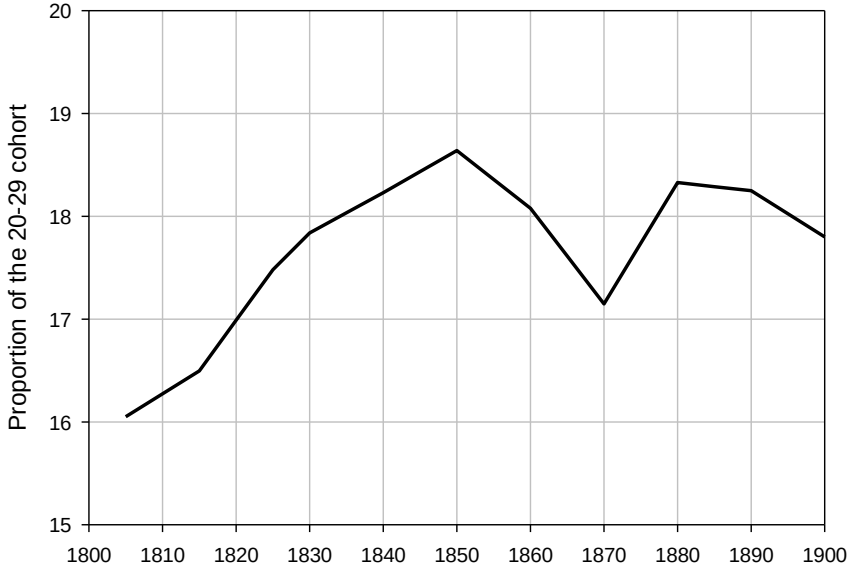

Figure 4. Proportion of the cohort aged 20–29 years among the total population of American white males. Data Source: Calculations by the author based on data in (Carter et al. 2004: Table Aa287–364).

proportion to the total population (N). The proportionality constant s is the number of government employees per total population. Empirically we know that s changed throughout the Antebellum period—the relative size of the federal government increased from roughly 0.5 to over 1 federal employee per 1,000 population (Carter et al. 2004: Table Ea894-903). I use this empirical information to track how s changed through time.

The dynamics of predicted MMP and EMP are plotted in Figure 5. MMP is essentially flat until 1820 (actually, it declines slightly), and then shifts to a growth regime thereafter. The dynamics of EMP are similar, but shifted in phase and more violent in amplitude. The decline lasts until the 1830s, and the increase during the 1840s and especially the 1850s is extremely rapid. After 1860 the model predicts a further rise in EMP, but this prediction should not concern us, because the Civil War fundamentally changed the American sociopolitical system, and the assumptions on which the model was built ceased to hold.

The final step is to combine these two measures within Political Stress Indicator, Ψ = MMP × EMP (Figure 6). The calculated PSI stayed at a low level (actually, gradually declining towards a minimum in 1830). It began increasing after 1840 and literally exploded during the 1850s. Comparing the predicted Ψ

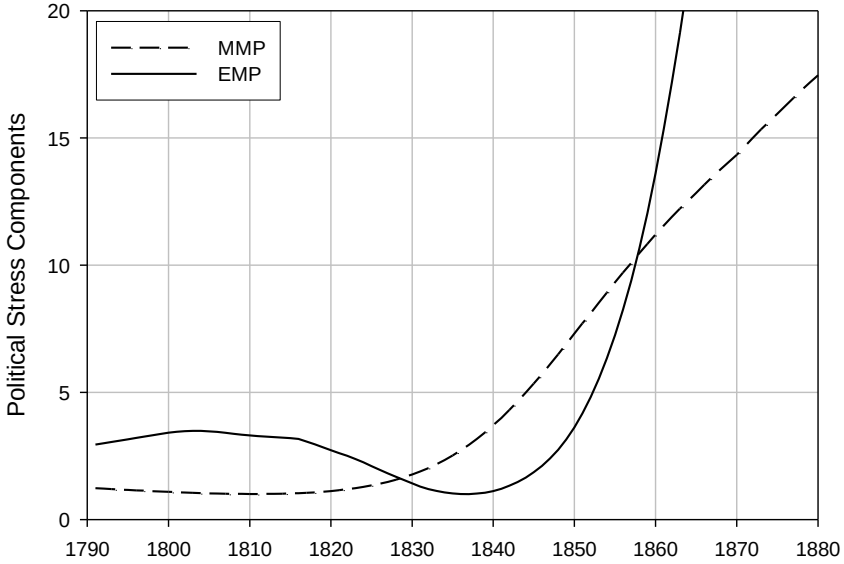

Figure 5. Dynamics of the two components of Political Stress Indicator, Mass Mobilization Potential (MMP) and Elite Mobilization Potential (EMP), predicted by the Antebellum model. Both indicators were scaled to minimum = 1.

to the empirical dynamics of sociopolitical instability measures suggests that Ψ can serve as a leading indicator of small-scale political violence which, in turn, is a leading indicator of a large-scale civil war.

Structural-Demographic Dynamics in Contemporary America

General Population and Well-Being

In this section I focus on structural-demographic causes of rising social pressures in the contemporary US. Since structural-demographic processes operate on the time scale of decades, in order to understand the historical roots of our current predicament, we need to look back roughly a century ago, to the New Deal and the period immediately preceding it.

Following the modeling framework developed earlier in this paper, I begin with the economic aspect of popular well-being—primarily, real wages. The chief empirical observation that we need to understand is why the robust and virtually monotonic pattern of real wage growth ended in the 1970s and was replaced by a regime of stagnation and decline (Turchin 2014: Chapter 11). The

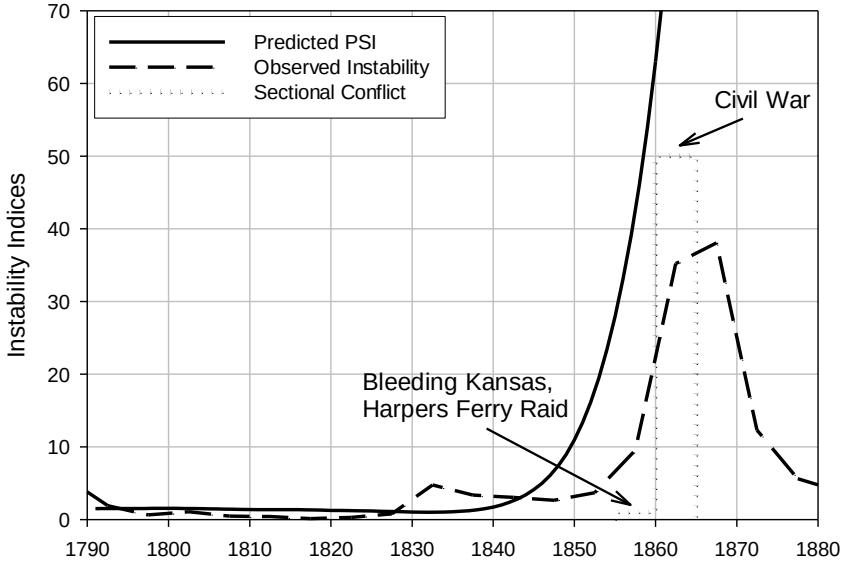

Figure 6. Predicted Political Stress Indicator compared with the observed dynamics of political instability: number of people killed in political instability events per million people and a qualitative index of sectional conflict, which includes Bleeding Kansas and John Brown's Harpers Ferry raid (1855–1860) and the American Civil War (1861–1865). Note that the two empirical indicators of instability are not shown to scale (the scale of casualties resulting from the Civil War exceeded that of the largest riot by two orders of magnitude).

general model for the dynamics of real wages is Eqn (1), which relates the real wage (W) to the real GDP per capita (G/N), the balance of labor demand and supply (D/S), and non-market forces ('culture', C).

An investigation of the empirical adequacy of the model (its ability to explain the long-term dynamics of W) requires data on the predictor variables (G/N, D/S, and C). Where direct data are not available, I need to find reasonable proxies. The first quantity, real GDP per capita, is readily available from a number of sources. The wages and GDP data are taken from MeasuringWorth (Officer 2007, Officer and Williamson 2009).

Estimates of labor demand and supply require more work. To a first approximation, we can estimate demand for labor by dividing the total amount of goods and services produced, G, by labor productivity, P (Blanchard 1997:512). Since P is usually measured as productivity per hour, the G/P ratio tells us how many hours were needed to produce the GDP for that year.

Assuming a 40-hour work week, there are roughly 2,000 hours per year per (fully employed) worker, so

$$D_t = \frac{G_t}{2000 P_t}$$

(Actually, a constant factor, such as 2,000 hours, does not affect the results of the analysis because all such factors are folded into the scale parameter a in Eqn. 1.) Note that the availability of data on labor productivity in the twentieth century allows for a more sophisticated approach to estimating the *D/S* ratio than was possible in the Antebellum model. I used the Bureau of Labor Statistics (BLS) data for labor productivity from 1947 to the present. For the period before 1947, I consulted Ferguson and Wascher (2004: Table 1). These authors give an overall estimate of labor productivity growth between 1927 and 1948 as 1.8 percent per year. Accordingly, I used 1927 as the first year of the data series for analysis.

Because real wages are expected to change slowly, in response to long trends in predictor variables (rather than short-term fluctuations of the business cycle), I smoothed all predictor variables using an exponential kernel smoother (Li and Racine 2006) with bandwidth $h = 4$ years. A smoothed GDP is known as 'potential' or 'trend' level of output (Samuelson and Nordhaus 1998:376). Real wage data, *W*, on the other hand, were not smoothed, because smoothing the response variable introduces biases into statistical estimation. (I also re-ran the analyses using unsmoothed predictor variables; the results were qualitatively similar, but the regression model explained a lower proportion of variance.)

A reasonable first approximation of labor supply is the total labor force in the United States. I took the data from HSUS (Carter et al. 2004) and the BLS for years after 1990. There is one problem: while BLS data include unemployed workers searching for work, they do not include those unemployed who have given up on finding a job and dropped out of the work force. It is likely that the Great Recession of 2007–9 caused increasingly large numbers of potential workers to withdraw from the labor force. Because I was unable to find numerical estimates of this problem, my estimate of *S* probably underestimates the true labor supply, a problem that has become especially severe in the last few years.

Plotting the estimated trends in labor demand and supply on the same graph shows that at the beginning of the period the demand curve grew faster than the supply curve (Figure 7). During the late 1960s, however, the supply curve accelerated and quickly outpaced the growth of demand. Two processes explain this acceleration. One was the reversal of immigration policy in 1965 that facilitated the arrival of workers from overseas. By the early 2000s, one in six American workers was foreign-born. However, the initial rise during the late sixties and the seventies was primarily driven by the second factor,

internal demographic growth. The generation that reached marriageable age during the Great Depression and World War II had fewer babies than the post-war generation (the parents of Baby Boomers). When Baby Boomers began entering the job market in massive numbers after 1965, they quickly drove up the supply curve above the demand (see Easterlin 1980, Macunovich 2002).

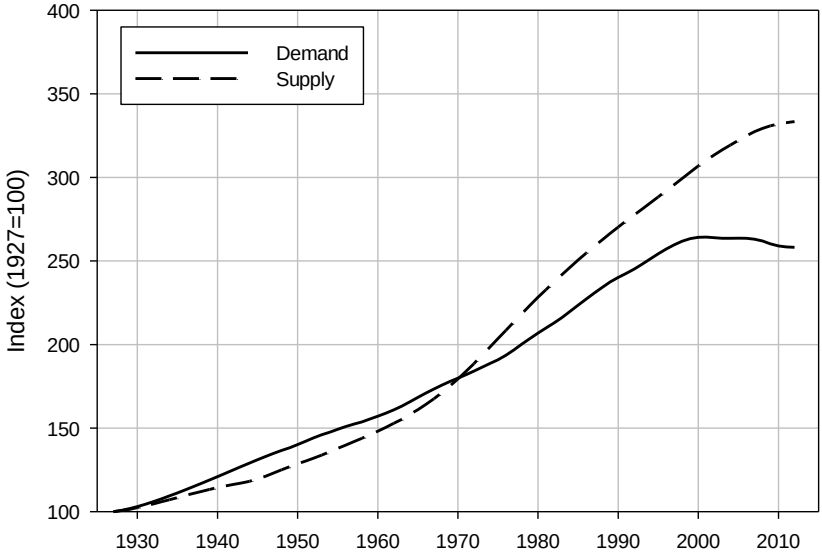

Figure 7. Trends in labor demand and supply (the United States, 1927–2012). Both time series have been scaled so that 1927 = 100. Source: calculations by the author based on data from MeasuringWorth, HSUS, and BLS.

Another turning point was reached around 2000, when the demand curve stopped growing altogether. This remarkable occurrence was due to a combination of sluggish economic growth and rapid gains in labor productivity, which put a lid on the number of workers needed to satisfy the demand for labor. Notice that the plateau occurred before the Great Recession, and it provides one possible explanation for the 'jobless recovery' following the Recession of 2001.

Overall, the trends in demand and supply curves appear to yield interesting insights into the forces shaping the dynamics of American real wages. However, before we can quantitatively estimate the relative effects of the *D/S* ratio on wages, we need to quantify the dynamics of extra-economic factors. Non-market forces affecting real wages include a whole host of potential mechanisms. These mechanisms can either promote growth of wages, or hold them down. For example, during the Great Depression there was a broad

consensus among the political and business elites that worker wages should not be lowered (Turchin 2014: Chapter 10). As a result, real wages actually grew quite vigorously between 1929 and 1941, helped along by a deflation of prices.

During World War II, on the other hand, millions of Americans were put into uniform and sent to fight overseas. The supply of labor dropped (even despite many women entering the labor force for the first time). At the same time war demanded a huge increase in the output. During this period worker wages grew, but much less than if they were driven up by pure economic forces of demand and supply. The reason was that the government (through the National War Board created by President Roosevelt in 1942) actively intervened in suppressing labor disputes and restraining wage growth (Schumann 2001).

Over the long term, the whole period from the New Deal through the Great Society was characterized by government policies that promoted labor unions and outlawed various business practices designed to suppress unionization. As a result, the proportion of unionized workers increased from 7–8 percent in the early 1930s, before the passage of the National Labor Relations Act (NLRA) in 1935, to over 25 percent between 1945 and 1960 (Figure 8). In the 1970s and 1980s, union coverage of workers rapidly declined, and currently it is at the level of 12 percent. The decline of union membership in the private sector was even more pronounced: from 35 percent in the 1950s to 7.6 percent in 2008 (Schmitt and Zipperer 2009).

Various explanations have been proposed for this decline, but recent research, summarized and extended by Schmitt and Zipperer (2009), indicates that the most important factor was efforts by the firms to derail unionization campaigns. One of the methods used to defeat union drives was firing pro-union workers, which is illegal under the NLRA. The frequency of union election campaigns in which employers used illegal firings as a disruptive and intimidating tactic grew during the 1970s and reached a peak in the early 1980s, when roughly one in three unionization campaigns was marred by illegal firings (Figure 8). Between the 1950s and 1980s the probability that a pro-union worker would be fired during a union drive increased more than 10-fold (Schmitt and Zipperer 2009: Figure 2).

There is no consensus among economists on whether a decline in unionization has contributed to wage stagnation. While labor unions definitely increase the wages of unionized workers, by an estimated 10–15 percent on average, most economists believe that labor unions distribute income from nonunion to union workers, and that the effect on the overall real wages is negligible (Samuelson and Nordhaus 1998: 238). Whether this assessment is correct, or not, the undeniable fact is that the social mood among the American elites with respect to labor unions has undergone a sea change during the 1970s.

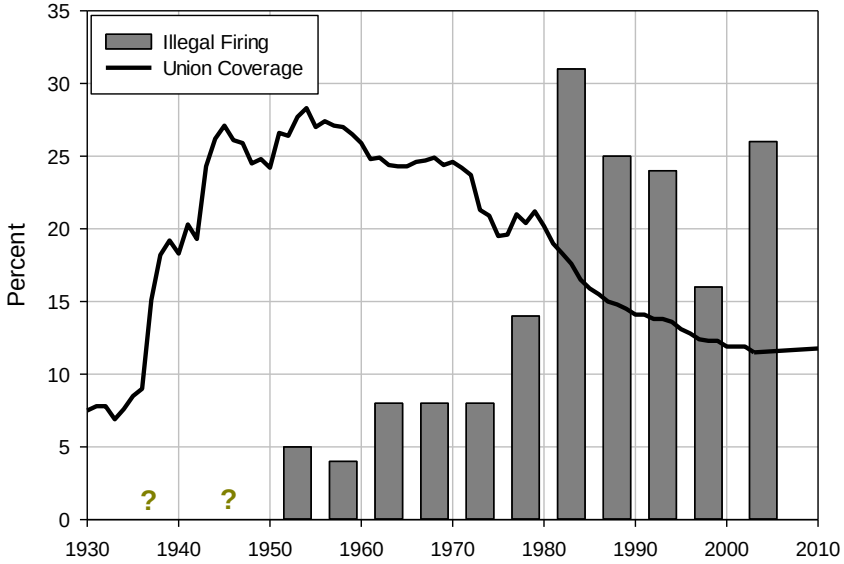

Figure 8. Labor union dynamics. The curve indicates the proportion of workers covered by unions, 1930–2010. The bar chart traces the proportion of union election campaigns in which pro-union workers were illegally fired, 1951–2007. Data sources: Union coverage (Mayer 2004), supplemented by BLS data; illegal firing (Schmitt and Zipperer 2009).

As the historian Kim Phillips-Fein wrote in *Invisible Hands* (2009:33), despite their initial resistance to the New Deal policies regulating labor-corporate relations, by the 1950s

> many managers and stockholders, executives and owners, did in fact make peace with the liberal order that had emerged. They began to bargain regularly with the labor unions at their companies. They advocated the use of fiscal policy and government action to help the nation to cope with economic downturns. They accepted the idea that the state might have some role to play in guiding economic life.

However, the social mood among the American elites began to change during the 1970s. As a result, that decade saw a spurt of growth in pro-business lobbying (Hacker and Pierson 2010:118). By the late 1970s a new generation of political and business leaders had come to power. This change of guard was particularly noticeable in the Republican Party. The Young Republicans, who included Newt Gingrich (elected to Congress in 1978), Vin Weber (1980), Dick Armey, and Tom DeLay (1984), were critical of the old-guard congressional GOP leadership that, in their opinion, was too comfortable with the art of compromise (Hacker and Pierson 2010:190). One factor contributing to the

growing feeling of discontent among these political leaders and their supporters within the business community was the decline of top incomes and wealth. During the Bear Market of 1973–82, in particular, capital returns took a strong beating and the high inflation of that decade ate into inherited wealth.

Although the election of President Ronald Reagan in 1980 and the beginning of 'Reaganomics' was its most visible symbolic manifestation, the actual cultural shift took place several years before. While the presidency of the Republican Richard Nixon continued the Great Society policies of the Lyndon Johnson era, the policy under the Democrat Jimmy Carter was much more similar to the subsequent Reagan era.

United Auto Workers president Douglas Fraser described this cultural shift in his famous resignation letter to the Labor-Management Group (Fraser 1978) as follows:

> I believe leaders of the business community, with few exceptions, have chosen to wage a one-sided class war today in this country—a war against working people, the unemployed, the poor, the minorities, the very young and the very old, and even many in the middle class of our society. The leaders of industry, commerce and finance in the United States have broken and discarded the fragile, unwritten compact previously existing during a past period of growth and progress.

What is remarkable about the letter is that it was written in 1978—the year when real wages stopped growing. However, it was not at all clear at the time whether it would be just a 'blip', or actually the beginning of a new long-term trend. Furthermore, the anti-labor union push from the corporations, similarly, only gathered momentum in the 1980s (Figure 8), during the Reagan presidency (with the defeat of the 1981 Air Controllers strike as the symbolic turning point). In other words, the cultural and ideological shift that Fraser describes preceded the shift in economic and state-related structural-demographic variables. This observation is consistent with the idea that cultural factors were one of the causes of the 1970s trend reversal.

Another significant change that we can trace back to the 1970s is the erosion of the real minimum wage due to inflation and the failure of the American political system to increase the nominal minimum wage to counteract inflationary pressures. Prior to 1970, the overall (smoothed) trend in the real minimum wage was up, and between 1950 and 1970 the real wage doubled (Figure 9). After 1970, however, the wage declined before equilibrating at a lower level during the 1990s and 2000s.

The dynamics of the minimum wage, thus, trace a cycle that shares many similarities with variables reflecting employer-employee relations. This is not surprising, because the value of the minimum wage reflects the shifting cultural and political attitudes toward what is the appropriate level of pay for unskilled labor. From the New Deal to the Great Society these non-market

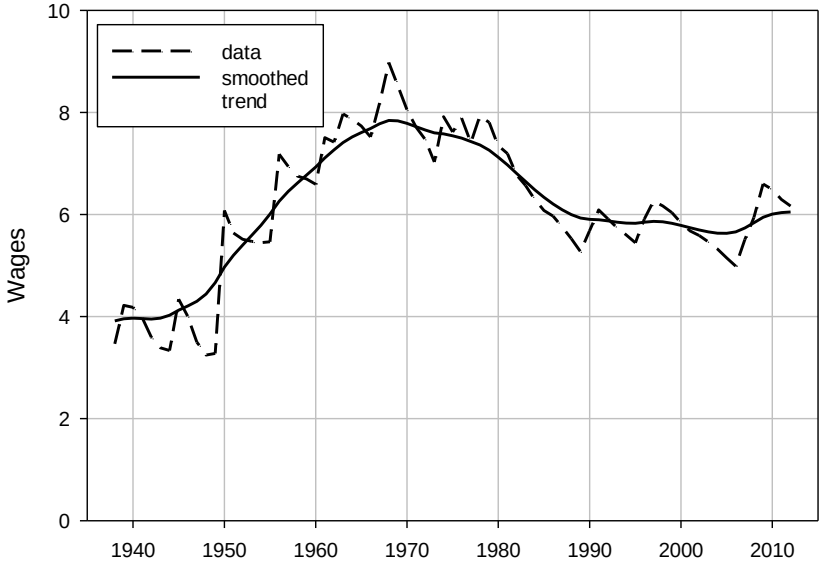

Figure 9. Dynamics of the real minimum wage, 1938–2012. Data source: US Department of Labor.

forces pushed the wage up faster than inflation. During the 1970s, however, an opposing trend gained the upper hand, allowing the minimal wage to decay as a result of inflation. These considerations suggest that the smoothed trend of the real minimum wage may serve as a reasonable proxy for the hard-to-quantify effect of the non-market forces. An additional advantage of this particular variable is that it is expressed in the same units as the quantity that we aim to model and understand (inflation-adjusted dollars per unit of work time).

It is worth emphasizing that what is important here is not the direct effect of the minimum wage on overall wages. The direct effect of changing the minimum wage on worker wages is likely to be slight, because it affects a small proportion of the American labor force. Furthermore, many states set their minimum wages above the federal level. Thus, the primary value of this variable in the analysis is as a proxy for the complexity of non-market forces.

We now have all the quantitative ingredients—GDP per capita, labor demand/supply ratio, and a proxy for non-market forces. I now put it all together in a statistical analysis that quantifies the effects, if any, of these three factors on real-wage trends. My modeling strategy is to add one explanatory variable at a time to the regression model (see Eqn 2) and at each step evaluate the improvement (if any) of the fit between the data and the model, both

quantitatively (with the coefficient of determination, R^2) and qualitatively (by observing whether the regression reproduces upward and downward trends in the data). Once this process is completed, I estimate the values of parameters by fitting a regression model with autocorrelated errors. The overall goal of the analysis is to determine whether the three-factorial model can explain the dynamics of real wages.

The regression that includes only the effect of growth in GDP per capita predicts a steady and monotonic increase in real wages (Figure 10a). There is no hint of a break in the GDP curve during the late 1970s, because GDP per capita grew fairly steadily, although sometimes at a faster, and at other times at a slower rate. However, the growth rate of real wages outpaced that of GDP per capita before the 1970s, while the growth rate of GDP per capita outpaced that of real wages after that decade.

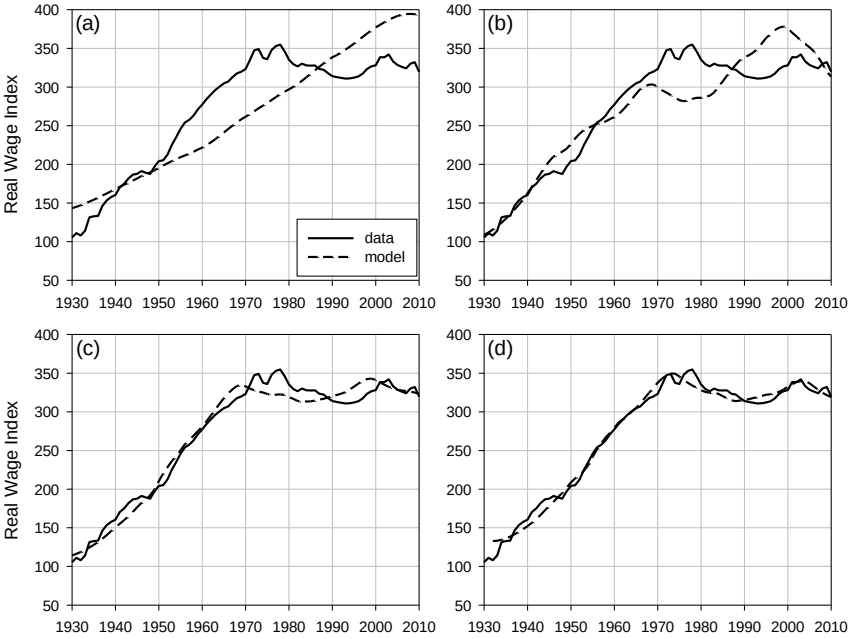

Figure 10. Results of fitting various forms of the regression model (2) to the data: (a) including only the effect of GDP per capita (no time lag), (b) including both GDP and labor demand/supply ratio (no time lag), (c) including all three factors (no time lag), and (d) the full model (time lag = 5 years).

The regression model that takes into account both GDP (per capita) and labor supply/demand ratio generated the fitted curve that is shown in Figure 10b. The two-factorial model explains data substantially better than the model

with just GDP (the coefficient of determination, $R^2 = 0.93$, compared to $R^2 = 0.73$ for the one-factorial model). The predicted curve hints that demand/supply ratio may be responsible for some of the trend reversals in the data, but overall, the model is not particularly satisfactory.

Adding minimum wage as the proxy for non-market forces results in a dramatic improvement in the match between the model-generated trajectory and data ($R^2 = 0.98$). The three-factorial model now predicts both regimes of vigorous growth and stagnation (Figure 10c). However, notice that the break point in the fitted curve, when it shifts from the growth to the stagnation regime, occurs several years before the break point in the data. As I discussed earlier, this is the expected pattern. As economic conditions change (for example, supply begins to overtake demand for labor), wages do not adjust to the new situation immediately. Labor contracts need to run their course and be renegotiated, and both employers and employees do not yet know whether this year's conditions are part of a long-term trend, or just a temporary spike. This means that real wage this year actually reflects the social and economic conjuncture that obtained several years ago.

Setting the lag time to 5 years yields a trajectory that matches the switch point from growth to stagnation regime (Figure 10d). This is, of course, not surprising, because the delay parameter was selected to account for this feature of the data. What is surprising is that the model now accurately predicts fluctuations of real wages during the stagnation phase: down during the 1980s, up until the early 2000s, and then down again. Such fine-scale correspondence between the model trajectory and data is entirely unexpected, and serves to further strengthen confidence in the ability of the model to capture the forces driving the dynamics of real wages.

Formal statistical analysis with a regression model that accounts for autocorrelated errors (Table 1) confirms that all three components are needed to replicate the data pattern.

Table 1. Results of regression analysis of real wage data using the R function arima (and checking the results with the function auto.arima in R package 'forecast'). Model selection with the Akaike Information Criterion (AIC) suggested that the best model includes all three predictors, as well as ARIMA(1, 0, 1) terms.

Factors	Estimate	Standard error
GDP per capita	0.60	0.07
Labor demand/supply	1.65	0.31
Real minimum wage	0.45	0.08
AR1	0.74	0.09
MA1	0.65	0.10

The conclusion is that real wages grow faster, or slower than 'per capita income' as a result of an interplay between market forces (captured by the labor demand/supply ratio) and cultural influences (proxied by the real minimum wage).

Modeling Elite Overproduction and Intraelite Competition

Relative wages (wages in relation to GDP per capita) are a fundamental driver in the structural-demographic model. In addition to being the most important part of MMP, relative wage levels affect the dynamics of the elites (and, indirectly, MMP). Of particular interest are the dynamics of relative elite numbers, e (the numbers of elites in proportion to the total population), which in the general model is governed by the following equation (see *Quantifying Social Pressures for Instability*):

$$\dot{e} = \mu_0 \frac{w_0 - w}{w} \tag{13}$$

where the dot over e indicates that it is e's rate of change, w is the relative wage (a dynamical quantity), and μ_0 and w_0 are fixed parameters. The main implication of this equation is that elite numbers relative to the general population should increase when relative wages are low and decline when relative wages are high (reflecting the balance of upward versus downward social mobility).

As a result of a complex interplay between market (labor supply vs. demand) and nonmarket (socio-cultural norms and institutes) forces, as we saw above, the relative wage increased between 1930 and 1960, lost some ground between 1960 and 1977, and took a plunge during the last two decades of the twentieth century (see the dotted curve in Figure 11).

Using the data on w as the driver in equation (13) predicts two distinct dynamical regimes for e. First, there is a long period of gentle decline starting during the Great Depression and continuing to the eve of the Reagan Revolution. After 1980, however, the relative elite numbers begin to increase at an accelerating rate (the solid curve in Figure 11). The dynamics shown in Figure 11 were generated using parameter values $\mu_0 = 0.1$ and $w_0 = 1$, but the behavior is generic to any reasonable parameter values. Variation in w_0 advances or delays the turning point by a few years, while μ_0 determines solely the amplitude (the difference between the trough and peak). Essentially, the shape of the e-curve is determined by the shape of the w-curve.

The second aspect of elite dynamics is relative elite income, ε (the average elite incomes scaled by GDP per capita). Recollect that this quantity in the model is determined by two factors. First, falling relative wages increase the proportion of GDP that is shared among the elites. However, and second, the more elites there are, the less is the average share of each. Interplay between

these two factors results in complex dynamics for this variable (the dashed curve in Figure 11).

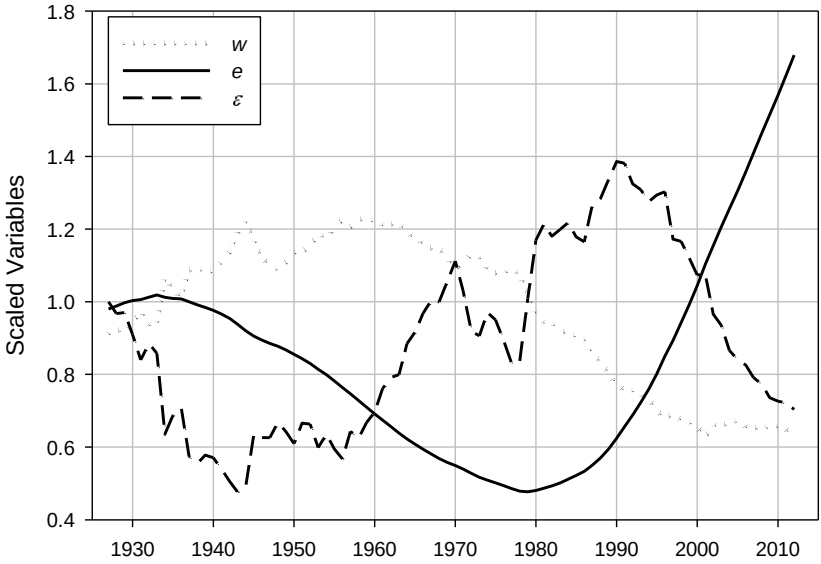

Figure 11. Dynamics of the elite submodel of the general structural-demographic model, 1927–2012: relative wage, relative elite numbers, and relative elite income. All relative variables were scaled to mean = 1 for the Pre-War period (1927–40).

The Great Depression was associated with a rapid plunge in elite incomes. After 1955, however, ε began to recover, driven primarily by declining elite numbers in relation to the general population. This period of recovery was interrupted by the Bear Market of 1973–82. After 1978 elite income growth resumed, this time driven primarily by the precipitous plunge in w. At the same time elite numbers began to grow, and when this process become explosive, expanding e rapidly diluted average elite incomes, which began their decline after 1990.

It is important to remember that ε does not index income (scaled by GDP per capita) of some 'typical' elite household. Because the distribution of top incomes usually follows a power law, there are no 'typical' incomes. Rather, ε is an (inverse) index of intraelite competition for economic resources. Low ε, either resulting from too small a pie that the elites divide among themselves, or too many eaters at the table, indicates high intraelite competition, while high ε, conversely, indicates a low level of competition for economic resources. (For this reason, the inverse of this quantity, ε^{-1}, enters the elite submodel of the

Political Stress Indicator, together with a second term that reflects competition for a limited supply of public offices.)

The elite submodel, thus, predicts a very substantial increase in relative elite numbers (roughly, three-fold since 1980) leading to an intensification of intraelite competition. How do these predictions square with data?

One way to check this result is to examine the dynamics of the numbers of top wealth-holders as proportion of the overall population. These data suggest that the percent of millionaires and multimillionaires expanded between 1983 and 2007 several fold (Table 2). In particular, the expansion rate of household with net worth exceeding 1 million and 5 million (2 and 4, respectively) brackets the theoretical prediction.

Table 2. Proportion of millionaires and multimillionaires in relation to the total population, 1983–2007 (Wolff 2010: Table 3). Net worth is calculated in constant 1995 dollars.

year	Percent of households with net worth exceeding:		
	1 mln	5 mln	10 mln
1983	2.9	0.29	0.08
1986	3.3	0.32	0.07
1992	3.3	0.29	0.04
1995	3.0	0.48	0.19
1998	4.7	0.74	0.23
2001	5.5	1.00	0.32
2004	5.8	1.00	0.31
2007	6.3	1.26	0.40

There is also evidence that growing numbers of wealth-holders have resulted in greater competition for political office. The clearest evidence of competition is the exploding 'price' of getting elected. Thus, the cost of winning an election to the House has more than doubled (in inflation-adjusted dollars) between the 1980s and 2012 (Figure 12). The total amount spent per election grew even faster, approaching a billion dollars in 2010.

Even more direct evidence of elite overproduction comes from the Center for Responsive Politics, which has been compiling data on the number and composition of candidates that compete for House and Senate seats. Between 2000 and 2010 the number of contenders for House grew by 54 percent, and for Senate by 61 percent. Note that the number of candidates who actually run is an underestimate of demand for political office. As its price increases (Figure 12), a larger proportion of potential candidates are deterred from running.

Beginning in 2002 the Center for Responsive Politics started keeping track of how many "millionaires" run for Congress (adding together the Senate and the House). The Center's research staff defines millionaire candidates as those

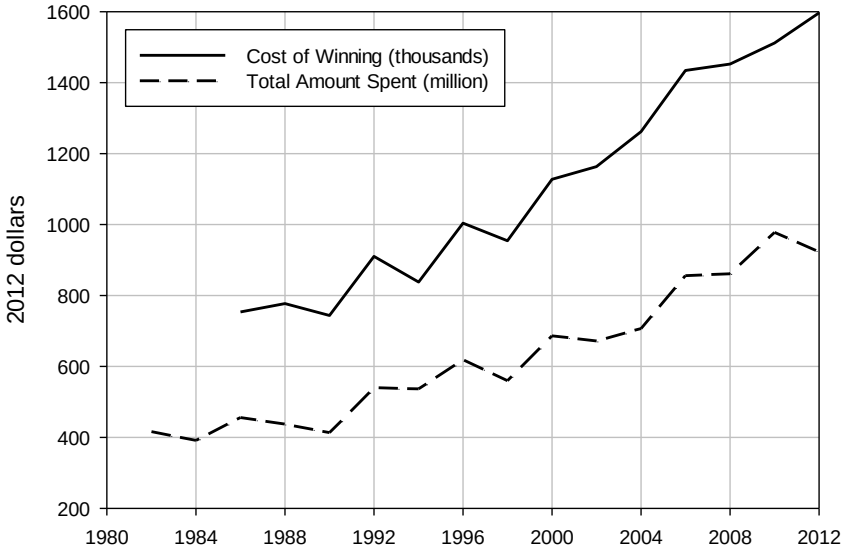

Figure 12. The cost of winning an election to the House, 1986–2012 (in thousands of inflation-adjusted 2012 dollars) and the total amount (in millions of 2012 dollars) spent by major party candidates. Data source: The Campaign Finance Institute.

Table 3. Numbers of candidates (including the primaries) that ran for House and Senate seats: 2000–2012. (Source: Center for Responsive Politics, OpenSecretes.org)

year	house	senate	both chambers	millionaires
2000	1233	191	1424	*no data*
2002	1299	146	1445	32
2004	1212	189	1401	30
2006	1317	166	1483	42
2008	1377	168	1545	51
2010	1897	308	2205	58
2012	1711	251	1962	48

who spend at least half a million dollars of their own money on the campaign. According to this definition, between 2004 and 2010 the number of such millionaire candidates nearly doubled. In summary, the empirical trends are entirely consistent with the structural-demographic prediction. Both the

candidate numbers and the growing cost of running for office appear to reflect intensifying intraelite competition.

Estimating the Political Stress Indicator (PSI)

Combining together definitions of PSI components (see *Quantifying Social Pressures for Instability*) yields

$$\Psi = \text{MMP}\times\text{EMP}\times\text{SFD} = w^{-1}\frac{N_{\text{urb}}}{N}A_{20-29}\ \varepsilon^{-1}e\ \frac{Y}{N}D \tag{14}$$

Most of the quantities in this equation can be estimated directly. Thus, the main component of MMP, the relative wage w, is the worker wage scaled by GDP per capita (data source: Officer and Williamson 2013). As for the other components of MMP: the urbanization rate, N_{urb}/N, is given in the *Historical Statistics of the United States* (Carter et al. 2004) and the youth bulge index, A_{20-29}, was obtained from the US Census Bureau. On the other hand, the EMP components (relative elite numbers, e, and relative elite incomes, ε) need to be estimated indirectly (see previous section and Figure 11).

To complete the estimation of PSI we need state-related variables, national debt scaled by GDP (Y/N), and a measure of distrust in government institutions. These quantities are plotted in Figure 13.

Prior to 1980, the US national debt behaved in a very predictable way. Each major war (the Revolutionary War, the War of 1812, the Civil War, and World War I) generated a spike of public debt, which was then quickly repaid during the post-war years. The same pattern held for World War II. Beginning in 1980, however, the national debt began growing much faster than GDP. This was the first time this happened during a period of peace.

Unfortunately, we lack data on trust in government institutions prior to 1958, when the Pew Research Center conducted its first study of this key social indicator. It is likely, however, that the post-war decade enjoyed a low level of distrust in government, similar to the one observed in the late 1950s and 1960s (Figure 13). State legitimacy was badly damaged during the 1970s, as a result of the Watergate affair that lead to the resignation of President Richard Nixon. Since the 1970s the levels of social distrust fluctuated in a cyclic manner. However, each succeeding peak was higher than the preceding one.

Growing distrust in state institutions is particularly worrisome because it can combine with exploding public debt in unpredictable ways. So far, the United States has enjoyed a very low cost of servicing its public debt. However, given a very shallow level of generalized trust in state institutions, there is a real danger that investors in the US debt may suddenly lose confidence in the specific institution: in the willingness and ability of the US government to pay on its obligations. Political polarization and intraelite conflict (themselves a result of elite overproduction and internal competition), which contributed to

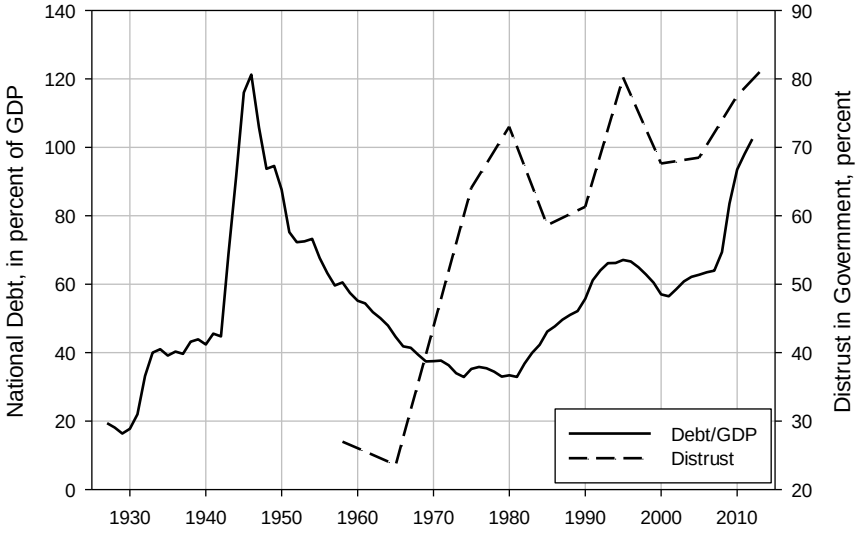

Figure 13. National debt scaled by GDP and proportion of people who distrust government institutions. Debt/GDP data are taken from the US Department of the Treasury. Distrust in government data are taken from the Pew Research Center (proportion responding 'some of the time' or 'never' to the question, "How much of the time do you trust the government in Washington?").

such policy failures as the 2013 government shutdown, are putting additional stresses on the social system. Sudden collapse of the state's finances has been one of the common triggers releasing pent-up social pressures toward political instability, including in such well-known cases as the English Civil War and the French Revolution (Goldstone 1991).

With all the ingredients of Eqn. 14 accounted for, I can put them together and estimate the dynamics of the overall measure of social pressures for instability, the Political Stress Indicator. Because data for D, a proxy for public distrust in state institutions, is not available for the period before 1958, I focus on the period from 1958 to the present (Figure 14).

Discussion

The Political Stress Indicator was developed by Goldstone (1991) with the concrete goal of quantifying structural-demographic pressures leading to the English Revolution. His results showed that the PSI can serve as a leading indicator of state breakdown and the outbreak of major political violence in this historical case study, as well as for the French Revolution and the

nineteenth century revolutions in France and Germany. Here I have used the same approach to study social pressures toward instability in the period preceding the American Civil War and in contemporary America. Although I use modified functional forms, the logical core of the approach is the same.

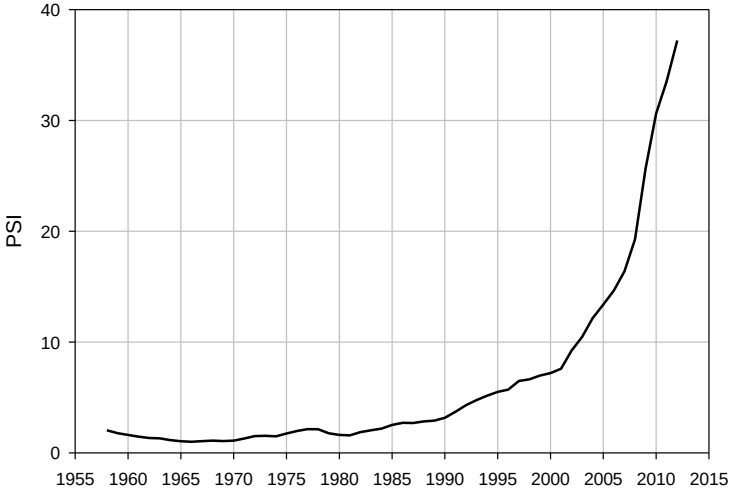

Figure 14. Estimated Political Stress Indicator, 1958–2012.

The core of structural-demographic theory is concerned, as its name implies, with how the effects of demographic processes on political instability are channeled through social structures. In the case of seventeenth-century England, the chief engine of change was simply a prolonged period of vigorous population growth. Its effects were labor oversupply, elite overproduction, and the increasing fragility of state finances, eventually resulting in the English Revolution and Civil War.

As the Antebellum model shows, the engine of change in the nineteenth-century US was somewhat more complex. As in England, there was vigorous rural population growth, resulting in massive migration to the cities. But there were additional processes: overseas immigration from Europe and emigration to the West (although these processes were roughly of the same order of magnitude and tended to cancel one another out).

In contemporary America, forces driving structural-demographic dynamics have been even more complex and include internal population growth combined with overseas immigration, globalization, increased labor participation by women, and changing cultural attitudes (which I proxied by real minimum wage). The end result, however, was the same in all three

cases—agrarian England, the industrializing United States, and post-industrial America. A growing gap between labor supply and labor demand and falling real wages were followed by elite overproduction, intraelite competition and conflict, and increasing sociopolitical instability (for the dynamics of political instability in the USA see Turchin 2012).

In the two historical cases, pent-up structural-demographic pressures eventually found a release in bloody civil wars. Similar to seventeenth-century English case investigated by Goldstone, the Antebellum model, developed in this article for nineteenth-century America, shows that PSI was an accurate leading indicator of these catastrophic outbreaks of political instability. However, the Antebellum model is not limited to constructing the PSI; it also delves into the interlinked mechanisms explaining why the PSI components, MMP and EMP, grew in the decades preceding the American Civil War. Thus, the Antebellum model provides an explanation of why relative wages began declining after 1820 and why an elite overproduction problem developed after 1840 (Figure 3).

The Contemporary model also investigates the causal factors responsible for trend reversals in the relative wage and relative elite numbers. Note that the dynamics of these variables during the twentieth century follow the same qualitative pattern as in the nineteenth century (compare Figures 3 and 11). In particular, the relative wage began declining roughly 20 years before relative elite numbers started increasing (Figure 11).

In the contemporary case we have, so far, avoided a full-blown civil war. Nevertheless we should pay close heed to the lessons from the historical cases, in which the PSI was a reliable lead indicator of catastrophic outbreaks of political violence. The estimated PSI began increasing after 1980, and has grown very rapidly after 2000 (Figure 14). Furthermore, during the decade of 2011–20, the structural conditions will continue favoring an increase in social pressures toward instability (Turchin 2010).

We saw that demand for labor has been stagnating since 2000, and this trend is likely to continue to 2020. The reason is that we are currently in the negative phase of the Kondratiev cycle, and are unlikely to emerge out of it until after 2020 (Akaev and Sadovnichiy 2009). At the same time, the supply of labor continues to increase due to population growth. According to the projections of the US Census Bureau, the numbers of youths aged 20–29 will peak in 2017–18, before they begin declining. In other words, the youth bulge is set to continue growing until the end of the decade. Unless political factors intervene (if, for example, the proposal by President Obama to dramatically increase the minimum wage is adopted), the growing gap between the supply and demand for labor will continue to depress real wages. Falling wages, in turn, will feed into the elite submodel; so both MMP and EMP are expected to rise.

As I wrote three years ago (Turchin 2010), we are rapidly approaching a historical cusp at which American society will be particularly vulnerable to violent upheaval. However, a disaster similar in magnitude to the American Civil War is not foreordained. On the contrary, we may be the first society that is capable of perceiving, if dimly, the deep structural forces pushing us to the brink. This means that we are uniquely equipped to take policy measures that will prevent our falling into the precipice.

Acknowledgment

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