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ORIGINAL PAPER

Censorship and mental models

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Abstract

In this paper, we propose a theory under which governments strive for ideological consensus, which they accomplish through shaping shared mental models. The extent of ideological consensus in turn influences the threat of revolution and extent of productive activities as these are understood by elites or interest groups. We use simulations to illustrate how government can manipulate or inculcate subjective beliefs in their citizens through censorship and propaganda. We model these policies as walls that partition "data" available to individuals, and the informational biases created can distort agents' economic calculation thus decrease their expected utilities. The simulations offer insight into the dynamics of censorship, mass education, and propaganda, as well as insights into cultural assimilation and the limits of mass education.

Keywords Ideology · Mental models · Censorship · Mass education · Propaganda

JEL codes H10 · P00 · D70 · N40

We don't need no education.
We don't need no thought control.
No dark sarcasm in the classroom.

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Teacher, leave them kids alone.
Hey, teacher, leave them kids alone.

— Lyrics from "Another Brick in the Wall" in album *The Wall*, Pink Floyd, 1979.

1 Introduction

Subjectivism plays an important role in several strands of public choice and constitutional political economy research going back at least to the Italian public finance economists of the late nineteenth century. For example, Amilcare Puviani's (1903) theory of fiscal illusion has influenced many scholars, including James Buchanan and through his work that of many other scholars. Central to this approach is that government officials may adopt various informational strategies to affect the beliefs of their citizens and thereby their economic and political decisions. Such effects may not be limited to inducing biased expectations as implicitly suggested by that literature. We suggest that such policies may also affect what Douglass North and Authur Denzau (1994) refer to as mental models or what Congleton (2018) refers to as internalized systems of rules for processing information and making decisions. Such effects tend to be broader and more durable than mere effects on expectations.

This paper provides a relatively simple model of the government control of information and its effect on individuals. The model is used as the basis for simulating the effects of such policies. Such effects, in turn, illustrate why governments might engage in such policies. In our model, which is loosely based on a Bayesian expected utility framework, information flows to individuals which provides the basis for their mental models. Government policies of censorship, mass education, and propaganda intervene in that process by controlling information flows and thereby altering the mental models that their citizens develop.

The simulations illustrate how such informational policies can affect mental models and thereby the choices of their citizens. Censorship does so by truncating the samples that individuals have available to them.

2 Censorship as a "Wall" or partitioning of the available information

Puviani's original discussion of fiscal illusion was motivated by efforts that he believed the Italian government of his time used to manipulate voter perceptions of tax burden. A similar point was made by Wagner (1976) in his analysis of the role that tax complexity plays in generating fiscal illusion. More recently Congleton (2001) demonstrated how ignorance (truncated data sets) can induce fiscal illusion even if voters make the very best use possible of the information at their disposal. This strand of research has thus been part of public choice scholarship for a long time.

Nonetheless, relatively little research has been devoted to the informational strategies that governments may adopt to induce such effects. In particular, there has been little or no analysis of censorship and propaganda. This paper undertakes such an analysis.

Most public choice research implicitly takes mental models as given rather than (partly) the result of efforts by government policies that attempt to induce beliefs within their citizenry.[1] For example, most of the fiscal illusion literature takes preferences as given and then analyzes how biased expectations may affect their policy choices. However, many governments do not take preferences or expectation (mental models) as given.

We suggest that governmental policies that regulate the information available to their citizens through censorship can induce systematic changes in the mental models of their citizens through time. These changes benefit government decision makers but usually not their citizens. This is especially true of authoritarian regimes. Recent changes in technology allow censorship and other informational policies to be undertaken on a larger scale than possible in former time, and thus it is arguably a more important issue today than it has been in the past. Governments of all kinds can exercise greater control over information flows to reinforce ideologies that legitimize their particular form of government and hierarchy of leadership.

The subjectivist perspective that underlies most models of fiscal illusion is used herein as the basis for developing a theory of the effects of censorship on citizen assessments of their governments and public policies.

One important contemporary instance of this is China. Previous research and a good deal of news reporting in the West has argued that the Chinese government has used its extensive control of information to promote its political goals (King et al., 2013, 2014, 2017; Zhou, 2018). For example, the "Great Firewall" was established by the Chinese government in the 1990s, just a few years after internet arrived in China. Since then, additional internet censorship and propaganda have been employed within the Great Firewall. These combine physical border control with restricted access to the world wide web. Consequently, more Chinese people have been calling China "the walled nation."

China, of course, is only one of many countries that actively employ informational strategies to influence their citizens.

3 Bias and mistakes in an expected utility framework

To illustrate how censorship can influence voter assessments of their government, we use a quasi-Bayesian model of learning from an available data set as the basis for a few relatively straightforward simulations of the effects of government efforts to limit access to particular types of information.

In our model, there is a population of individuals with their own initial set of preferences and beliefs. A simulated government manipulates information through various means, including censorship, mass education, and propaganda. The information environment is one in which government can eliminate access to information (censorship) or provide (in a sense over sample) information directly to their citizens

[1] Some of the research on shared mental models has explored the extent to which people rely on "experts" in their learning process (Greif & Mokyr, 2017; Petracca & Gallagher, 2020). North (1981) also suggests that ideology increases the ability of large groups to solve their free rider problems.

through mass education and propaganda. Individuals in turn use the information they have to estimate a relationship that is less abstract, but which influences behavior with respect to their government—as with out-migration, protests, revolts, or revolution.

In an expected utility framework, individuals make choices based on their perceived utilities. Individuals maximize their expected utility, which is a function of their preferences and beliefs about the consequences of the different choices that they make. In settings where elections are important, voter choices can be modelled. In other settings, the induced beliefs may affect career choices, investment decisions, and efforts to express dissent in various ways. Public choice analysis of voter illusion and fiscal illusion recognizes that individuals may have illusions about the true effects of government policies due to truncated data sets.

We believe that the expectational representation of the effects of informational policies are a bit too narrow and prefer to think of their effects as systematic changes in the mental models, in the North and Denzau sense or on the systems of rules internalized in the Congleton sense. In any of these cases, government manipulation of information can lead to systematic mistakes in decision-making, such as failing to maximize utility due to an inaccurate understanding of their choice setting.

Our model of the mental model evolution operates as follows: An individual's mental model at time *t* is jointly determined by their mental models (or priors) at time *t*−*1* and new information acquired at time *t*. The information flow is broadly defined to include education, propaganda, communication with other agents, and any other new information about their environment that is taken in by an agent at time *t*.

$$MentalModel_1 \;=\; M(Endowment_0,\; Information_1) \tag{1}$$

$$MentalModel_t \;=\; M(MentalModel_{t-1},\; Information_t) \tag{2}$$

Mental models and their associated systems of rules are gradually developed through time, as agents accumulate information and process the information accumulated in successive periods of their lives.

This process is largely what is meant by learning. In this paper we have a particular type of learning in mind: the development of and refinement of theories (mental models, systems of rules, and their associated expectations) that are used by individuals to interpret the world.

Given an agent's mental model at time *t*, the agent's economic and political choice, such as a choice of private investments or between candidates in a democratic political system, is affected by their perception of the truth, which may be biased (somewhat mistaken). Bias induces their choices to deviate from the optimal choice they would have made if their assessments were unbiased. A general formulation of the effects of mistaken choices can be represented as follows:

$$Expected\,Utility_t \;=\; U(|Mental\;Model_t - Truth_t|) \tag{3}$$

where the first order derivative is negative. The farther an agent's perception of the facts and their relationships deviates from the truth, the lower is their expected utility.

4 Simulated case studies

We use simulations to illustrate how intervention by a government can affect the shared mental models of their citizenry. We do this by introducing either a one-time bias in the information available during an initial stage of their life (as might be induced by state sponsored education) or by inducing cumulative biases in the later stages of life (via censorship, surveillance, and propaganda).[2] Although simulation models are necessarily less than perfect, they allow us to illustrate how mistaken choices can be induced through various forms of governmental informational policies.

Having unbiased information about events, public policies, and "if-then" relationships produces more informed decisions by individual agents and thus fewer mistakes. Such mistakes may affect elections (Congleton, 2007) or assessments of public policies or of investment opportunities and career choices (Congleton, 2001). To keep the results as general as possible, our analysis simply assumes that an individual's expected utility is negatively related to the bias induced by governmental policies.

Individuals are assumed to make observations and draw conclusions from a data set that is controlled or potentially controlled by a government. The observations in period *t*, are assumed to affect causal models that individuals may form of the relationship between variable X_t and Y_t. The mental model of the underlying relationship in time *t* is estimated from a thousand randomly generated observations of *X* and *Y*—each representing an event in that period. The observations are assumed to be generated by a stochastic process. X_t is assumed to have a normal distribution with a mean of zero and standard deviation of one. Y_t is assumed to be generated by the linear relationship $y_{t,i} = a_t x_{t,i} + b_t$, where *a* and *b* both have a normal distribution with mean of zero and standard deviation of one. The mean zero assumption is simply one of many that could be made for purposes of illustration. In terms of government policy, it may be a policy that generally has no effect on the voter's income or some other outcome of interest to the voter-citizen.

Individuals are assumed to form and update their estimates of the $x_t \rightarrow y_t$ relationship in a hundred discrete periods throughout their lifetime, based on the observations that they observe in each period. The one hundred period assumption can be thought of as series of mental models during a very long lifespan, if each period is thought of as a year. The assumed mental model updating process is not instantaneous, so updates occur occasionally, with a lag, rather than every minute or hour.

If the estimated relationship between *X* and *Y* at the beginning of period one is $Y_1 = a_1 X_1 + b_1$, and the mental model at the end of period 1 (and beginning of period 2) is $Y_1' = \widehat{a}_1 X_1 + \widehat{b}_1$, there will be a systematic difference between Y_1 and Y_1' if bias has been induced, but not if both estimates are unbiased. If a bias has been induced, then $Y_1 - Y_1' = d_1$, and $|d_1| > 0$. In such cases, systematic errors will occur and expected utility falls.

[2] Simulations of the electoral and policy effects of information limitations and different signaling strategies were previously undertaken by Congleton (1986, 2007). However, Congleton does not model or simulate the possible effects of governmental informational barriers or censorship. Congleton (1991) does, however, model how rival interest groups may use information to alter electoral results and public policies.

In the baseline simulation (Sect. 4.1 for an open society), there is no government introduced bias nor limitation of the information set. In that case, the difference between Y_1' and Y_1 is minimal and a_1' and b_1' are both similar to the true a_1 and b_1 , thus there will be no significant bias in mental models. However, when we have a government introduced bias introduced through education or limits on the information set, then $|d_1| > 0$.

Mental models are generally considered to be relatively stable. We account for this effect and the path dependency of mental models through time by assigning a time-discount parameter ρ with value 0.9 in the simulation, unless otherwise specified. In the simulations, the model developed with information in period 1 continues to affect the model subsequently developed in period 2. Subsequent bias may gradually decline or increase according to the informational policies in place through time. The mental model in period 2 is $Y_2' = \widehat{a}_2 X_2 + \widehat{b}_2$, where $Y_2' = a_2 X_2 + b_2 + d_2 + 0.9 d_1$. The mental model of period 3, $Y_3' = \widehat{a}_3 X_3 + \widehat{b}_3$, can be written in terms of bias as $Y_3' = a_3 X_3 + b_3 + d_3 + 0.9(d_2 + 0.9 d_1)$, where a_3 and b_3 are the true values in period 3 and the various d terms characterize the systematic errors associated with the mental model at the end of period 3 (and beginning of period 4).

The lack of independence across time periods implies that early biases have continuing effects on mental models and associated expectations in future periods even in cases in which governmental information policies change from bias inducing to neutral, although the bias would gradually diminish as subsequent in-period unbiased estimates reduce the cumulative bias.

In most cases, the qualitative effects of censorship in our simulations are clear after twenty or thirty time periods. In other words, whether we use fifty, a hundred, or a thousand time periods does not meaningfully change the qualitive results. Changing the number of intra-period sample to five hundred, two thousand, or other relatively large numbers would not meaningfully change the results.

To summarize, the coefficients and intercepts of the relationships in the simulations are unstable from period to period, but stable within each period. The persistence of mental models creates a linkage between past and future models and biases. When there are no informational restrictions, there is no bias in the mental models. But, when governments use informational strategies such as censorship to influence mental models, biases may be created because those affected by the policies do not know what is missing—indeed, they may not be aware that they are missing any data that are important.

4.1 Baseline: an open society

The first scenario we simulate is the baseline situation without an informational wall or censorship, which we refer to as an open society. The implies that the x_t and y_t confronted are full-range simulated real-world causes and effects. An individual uses the observations of $x_{t,\,i}$ and $y_{t,\,i}$ to infer the average linear relationship between X and Y—which is their simulated mental model, and X and Y are both events or issues with X being the cause and Y being the consequences in the "if-then" relationships. In this case, if the true relationship is $y = f(x)$, the inferred relationship $y = \widehat{f}(x)$ is the essentially the same. It is an unbiased estimate of the relationship.

After estimating the relationship between X and Y in period t, the individual uses the inference to predict outcome y for any given new x in period $t+1$. For the purposes of the simulations, we use a simple OLS to estimate the relationship between X_t and Y_t, based on the 1,000 paired randomly generated observations in period t. Again, X_t is the one thousand causes observed in period t, and Y_t is the corresponding observed consequences in period t. After estimating the $Y_t = \widehat{a_t} Y_t + \widehat{b_t}$, the individual then uses this relationship to predict the $y_{t,i}$ if given any $x_{t,i}$.

The baseline simulation is presented in Fig. 1. It shows that despite small errors (biases) in every period, the overall bias is minimal and does not escalate. This is consistent with the classical liberal theory of learning, which assumes that the larger and less constrained an information set is, the more likely individuals are to fully understand their economic and/or political environments. This is one argument for supporting free speech and freedom in other areas (Congleton, 2007).

Below is the figure for one person's series of parameterizations of the linear relationship being estimated. The first panel of the figure is the individual's error in his

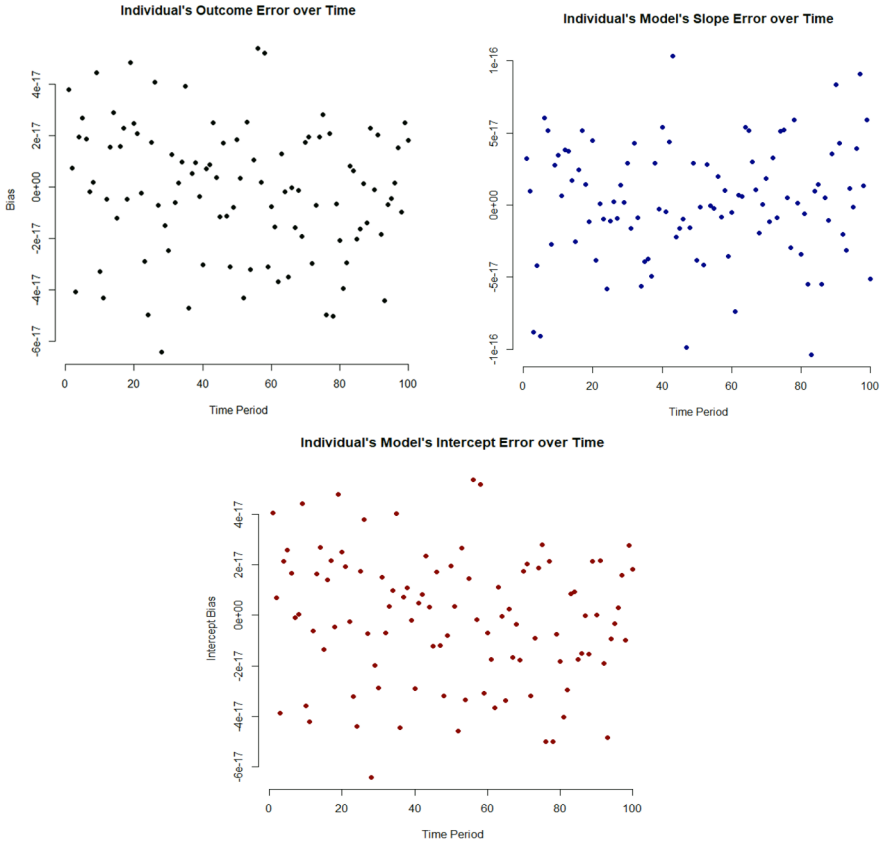

Fig. 1 An open liberal society

or her estimates of perceived Y_t in each time period. The second and third panels are that for their estimated slope and intercept.

4.2 Censorship: a walled society

The second set of simulations models the effects of censorship. Censorship makes an unbiased estimate of the $X_t \rightarrow Y_t$ relationship impossible because some events are outside the "wall" and so not accessible to individuals.

As with the baseline simulations, the event sets are X and Y; and, the relationship between X and Y follows the relationship $Y_t = a_t X_t + b_t$, where X, a, $b \sim N(0, 1)$. For paired events in any period t, $(x_{t,i}, y_{t,i})$, with $i = 1,\ldots, 1{,}000$, individuals can only observe those for which $y_{t,i} > b_t$. By eliminating access to the "negative" results, the government induces a positive bias.

Figure 2 presents the simulation results as scatter diagrams. As before, the simulations are run one thousand times, and the average estimate for Y_t in each period is reported. It shows that systematically truncating the information set available to individuals induces biased expectations and systematic mistakes. In the case, simulated,

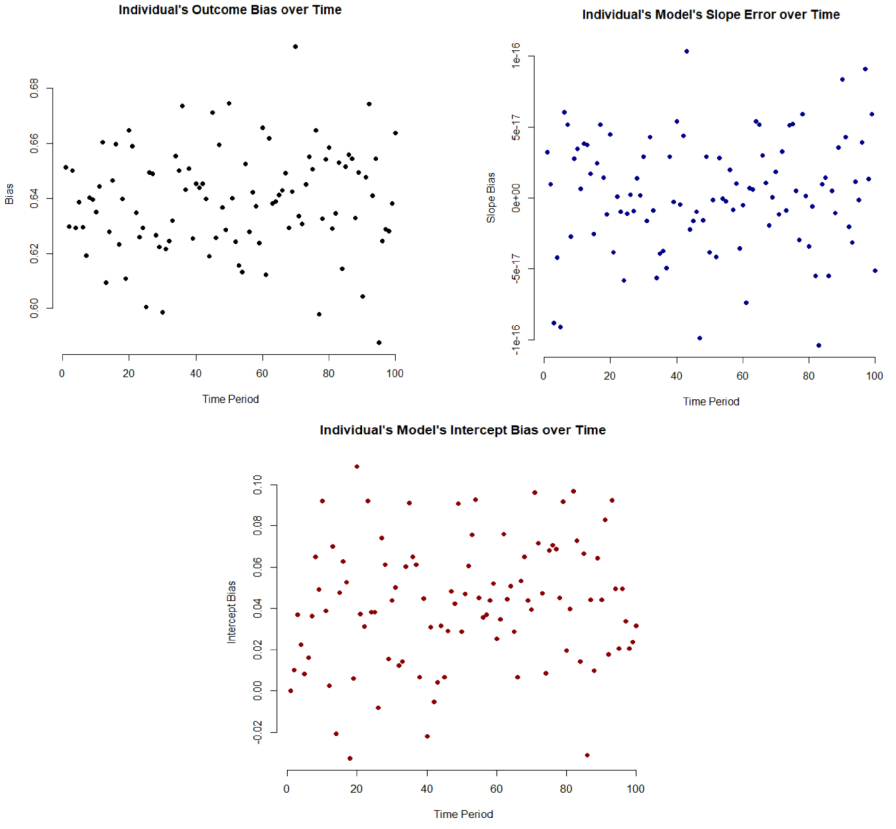

Fig. 2 A society with censorship

the bias is about 0.6–0.7 and shown in the top panel. Relative to the open liberal society as simulated in Fig. 1, the walled society in Fig. 2 indicates a significant outcome bias. The intercept bias, as shown in the third panel, is the main factor that leads to the estimate bias (here, interpreted as biased or mistake-prone mental models).

The simulation results imply that even if the mental models are only slightly different from the true one, when accurate estimates of y are important, then the mistakes induced by such biased mental models tend to be important as well. Then, because of the bias of the mental models, the consequences of choices for which the model is relevant are mistake prone.

In general, censorship, even when it is not an impenetrable wall, by increasing the cost of some types of information will affect expectations and choices.

That censorship has been observed many times in history implies that governments engage in censorship to alter the kinds of choices that their citizens are inclined to make. In democratic societies it may affect voting behavior and electoral outcomes. In authoritarian regimes it may reduce the probability of demonstrations, revolts, and revolutions.[3]

4.3 Mass education as a method of inculcating beliefs

Much of what is taught in school systems is unfiltered and useful, as might be said of arithmetic, spelling, reading, and physics. Such teachings improve our mental models by reducing cognitive errors in ways that tend to make students better off. However, mass education can also be used to induce biases, as when history is taught selectively and works that contradict or fill in the gaps are unavailable or difficult to acquire. Bias is easiest to induce in fields of knowledge in which students have no direct experience. In such cases, mass education has properties similar to censorship.

The next simulation illustrates possible biases that might be induced through mass education. This is modeled as an effect in the first stage of an individual's learning process. The bias may be introduced by focusing only on a particular subset of facts or by teaching falsehoods. Because of the bias, instead of the true relationship between X and Y in period 1 (that is, $\mathrm{y}_{1,i} = \mathrm{a}_1\mathrm{x}_{1,i} + \mathrm{b}_1$), the individual observes $\mathrm{y}_{1,i} = \mathrm{a}_1\mathrm{x}_{1,i} + \mathrm{b}_1 + d_1$ in period 1, without being aware of the bias in their information sets, with $d_1 \sim N(1, 1)$.

They use the sample taught as the basis of their models to infer the relationship between X and Y. When the students use this censored sample to perceive the relationship between X and Y, the perceived $\widehat{a}_1$ and/or $\widehat{b}_1$ are biased. The nature of the bias varies with the intent of the educational program. Education is assumed to directly affect only the initial stage. However, in the inertial models used above, the initial bias will be somewhat persistent. The bias in later peirods is $\rho \times Bias_1$ in period 2, $\rho^2 \times Bias_1$ in period 3, and $\rho^{t-1} \times Bias_1$ at in period t, where "ρ" has a value less than one, as experience gradually overcomes the initial bias.

The simulations for this educational affect are plotted in Fig. 3, which shows that even a fairly large bias in the initial stage may be overcome by experience—although

[3] North (1981) argues that the "cost of maintaining an ideological consensus is inversely related to the costs of information and directly related to the stability of relative prices" (65).

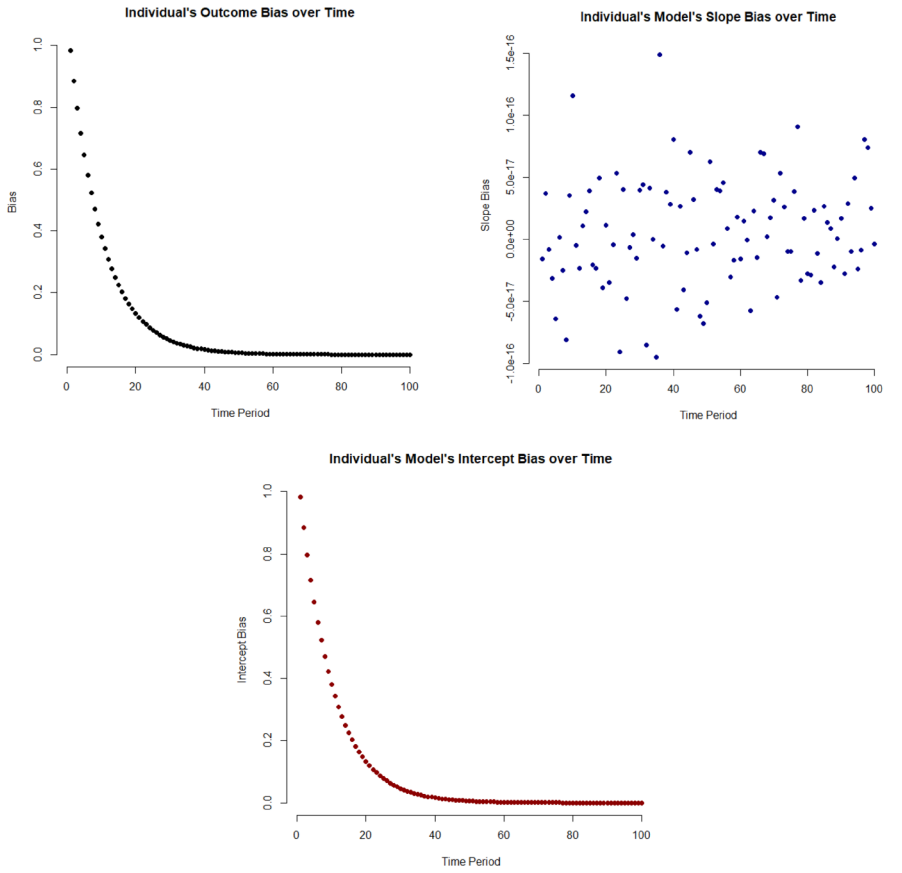

Fig. 3 Simulation—mass education (ρ=0.9)

mistakes will be made in the period in which this occurs. In the simulations, the bias approaches zero after fifty periods. This indicates how that life in an open society can overcome initial misconceptions, although it may take years of experience to do so.

4.4 Propaganda

The fourth simulation illustrates the effects of propaganda or continuing education. We retain the first stage from the third set of simulations and model the effects of propaganda in the post-educational period as a type of continuing "education." The bias in the initial stage is again $d_1 \sim N(1, 1)$, and ρ =0.9, as in all the simulations. In the new environment, government control of mass media and publications introduces a new bias $d_{t>1} \sim N(1, 1)$, which reinforces the bias generated by mass education.

In detail, in period 2, the mental model's perception of $y_{2,i}$ differs from the true $y_{2,i}$ because of propaganda in period 2 and the inertial bias from previous time periods. Figure 4 illustrates how the combination of ideological training in schools and active biasing of the information available through mass media tend to create sus-

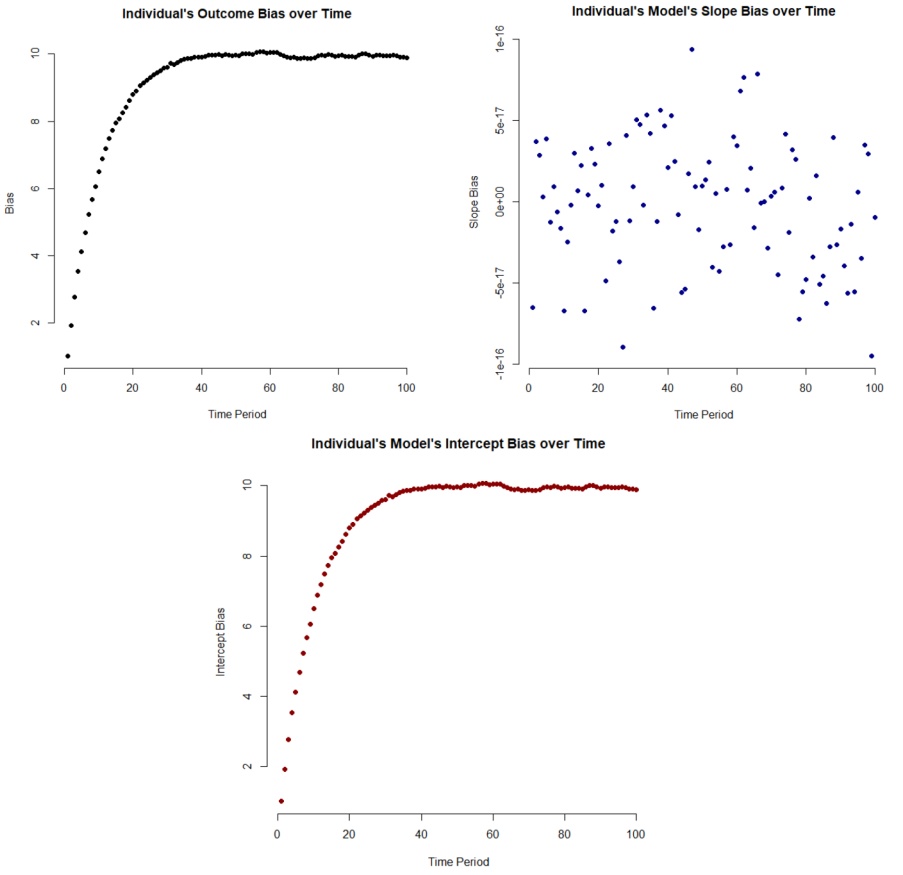

Fig. 4 Simulation—propaganda ($\rho = 0.9$)

tained deviations from the true values. Indeed, in the model parameterization used, the bias increases in successive periods. Propaganda (biased information) can also be by the private sector. However, in that case, the competition between rival groups may largely offset each other with respect to bias. For example, Congleton (1986, 1991) shows how rivalry between ideological groups may use various methods to influence voter or legislator preferences in democracies. In authoritarian governments, such competition does not occur.

That state control of media is a common means of propagandizing and is widely recognized. See, for example, Egorov et al. (2009), Gehlbach and Sonin (2014) or Edmond (2013), among many others.

5 Ideological intervention and nation building

Although explicit analysis is beyond the scope of the present paper, our model may shed light on efforts at nation building, where a state or coalition of interest group may attempt to induce feeling of national identity. A state or society may be more stable when some world views are more commonplace than others. For example, both Confucius and Plato each understood that one of the purposes of education to be the shaping national outlook, including character building. Thomas Jefferson (1785/1788) highlighted how a state-controlled education system can be used for propaganda directed at young people, and John Dewey (1920/2012) pointed out that the goal of a state education system is "creating individuals," not "obtaining something for individuals."

Nation building also involves increasing loyalty of a nation's citizenry and thereby reducing the cost of maintaining control (Wintrobe, 2000; Holcombe, 2023). Public education is often a political strategy that political elites use to deal with widespread social and political disorder, and to consolidate political power by instilling values of social order, respect for authority, and rule of law, or instill values, such as support or resistance to ideological ideas (Paglayan, 2021; Lankina et al. 2016; Lott, 1999).

Sutter (1998) argues that some degree of ideological consensus precedes constitutional consensus, though the extent of consensus is not absolute. As Sutter explains, ratification of the United States Constitution, which involved serious intellectual conflict between the Federalists and Anti-Federalists, even though both groups shared the goal of limiting governmental power. Though examples of ideological convergence exist for specific policies, constitutional consensus requires more widespread convergence on visions and may not occur, beyond basic agreements. Weingast (1997) also points out that democracy and the rule of law require that political officials respect limits on their own behavior. These boundaries depend to an extent on achieving some degree of consensus between the political officials and citizens. This suggests the importance of shared mental models to constitutional limitations on government power in liberal democracies. Meanwhile, though governments can manipulate mental models, there are limits to their ability to shape individual beliefs, mental models, and internalized systems of rules.

6 Conclusions

This paper develops a simple model of the way government manipulates information flows and consequences of doing so. Rather than view mental models as exogenous, we suggest that when governments use censorship and propaganda to induce biased expectations, the result may be changes in the mental models that their citizens use to interpret the world. Such induced world views would tend to benefit government leaders by changing the behavior of their citizens, making them more content with the status quo and less likely to protest or revolt.

This idea is not new to public choice, but relatively few efforts have been undertaken to illustrate how such effects might arise. Our simulations illustrate how quasi-Bayesian use of data may generate biases when the data sets have been manipulated.

The bias generated, in turn, has been interpreted as systematic effects on the world views or mental models used by individuals to understand the world that they live in, and those understanding, in turn, may lead to patterns of choice that broadly advance the interests of government officials.

Our aim has not been to completely model this process, but to illustrate how state control over information may operate to shape mental models and thereby behavior. More complete models are left for future research.

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Author contributions Both authors contributed to the manuscript with major efforts.

Data availability Simulation codes and data will be available when reasonable requests are made to the authors.

Declarations

Competing interests The authors declare no competing interests.

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