Institutions and Cultural Capacity: A Systems Perspective

Jenna Bednar*and Scott E Page†

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Abstract

Societies rely on a mixture of markets, hierarchies, and democratic institutions to allocate resources, make decisions, and establish order. The success of any one institution depends on its design features, the nature of the task, and the cultural capacities of the society within which the institution is embedded. In this paper, rather than consider cultural capacity as exogenous, we model institutions and cultural capacities as interdependent. We assume that different types of institutions build different types of cultural capacities. We define cultural-institutional equilibria as configurations in which cultural capacities are consistent with institutional choices, and institutional choices are optimal given tasks and culture. We highlight five results. First, consistent with existing models we find that positive feedbacks between cultural capacities and institutional performance produces multiple equilibria, providing one for why cultural capacities and ensemble compositions vary by place. Second, we show that cultural-institutional equilibrium are generically not efficient because of a disconnect between producing and leveraging cultural capacity. Third, we show that if one type of institutions, say markets, builds cultural capacities that hinder the performance of another institutional type, say democracies, the market expansion can lead to the demise of democracies. Fourth, we derive a *paradox of cultural capacity-building*. We show that an institutional type that builds too much generic cultural capacity all but disappear collapse as a result of making other types of institutions more effective. Finally, we show that synergies between types of institutions in capacity building can lead to a nonlinear increase in those institutional types. We connect this last finding to the growth in algorithmic institutions and markets that coincides with the decline in hierarchical organizations.

*Ford School of Public Policy and Department of Political Science, The University of Michigan-Ann Arbor and The Santa Fe Institute.

†Ross School of Business, The University of Michigan-Ann Arbor and The Santa Fe Institute.

In this paper, we analyze institutional choices and cultural capacity-building from a systems perspective. We model cultural capacities and institutional choices as interdependent. By cultural capacity we mean behavioral traits such as trust, risk taking, and rule following that influence the success of institutions (Swidler 1986). Initially, we consider the three traditional categories of institutions: markets, hierarchies, and democracies and later add self-organized communities, and institutions that rely on algorithms and machine learning. We adopt a systems approach in which the concentration of institutional types determines levels of various cultural capacities and those levels influence the efficiency of institutional types. Hierarchical institutions, for example, build rule following behaviors.

The cultural capacities, in turn, drive choices over institutions. Capacities can vary over time and by place. The founders of the United States did not trust citizens to directly elect senators or the president. They believed the people too susceptible to the influence of despots, so they constructed a hierarchical system on top of democratic mechanisms. Eventually, as the citizens became more educated and built cultural capacity, the US constitution was emended to allow for the direct election of senators. Cultural variation by place means that institutional choices may differ on common allocative tasks.[1]

In the paper, we focus our attention on five implications. First, we show that if cultural capacity-building is largely institution-specific, i.e., if markets build capacity for markets to perform well, then multiple outcomes can exist. Some societies may be market-dominated with risk-loving people. Others may be dominated by hierarchies with people who follow rules. Given evidence that maintaining a balance between adherence to rules and a willingness to challenge those rules is necessary for long-term economic success (Acemoglu and Robinson 2019), the potential for extremes is worrying.

Second, we show that, in general, cultural-institutional equilibria will not be efficient. Efficiency fails to hold because institutional types are selected based on their ability to leverage cultural capacity and not on the cultural capacity they build. Put simply, cultural capacity-building is a positive externality. A society might allocate housing hierarchically because is more efficient but had the society chosen a market, they might have produced more trust in institutions and stronger property rights that would have made other institutions perform better. Or, democracies and community-based institutions might both produce other-regarding behavior which would improve the performance of all types of institutions (Bowles 2018), but that positive externality is not a dimension of a social choice of institution.

Third, we show that when one institutional type hinders cultural capacity-building for another

[1] The European union relies more heavily on bureaucratically enforced environmental policies, while the United States relies more on market-based systems (Morag-Levine 2009).

institutional type, the second institutional type will be chosen less frequently. Thus, cultural spillovers from markets could, in theory, undermine the functioning of democratic institutions and vice versa. Fourth, we show that if one institutional type builds generalized cultural capacity, such as trust, then increases in the rate at which it produces trust can result in the collapse of that institutional type. That collapse also results in a dramatic reduction in overall efficiency. We refer to these two effects as the *paradox of cultural capacity-building institutions*

Finally, we analyze the effect of cultural capacity building synergies between institutional types by constructing a model in algorithms and markets build traits that both institutions can leverage. We find that for modest synergies, the effect on the distribution of institutions is minimal. Once the synergies reach a threshold , the model produces a dramatic change in the equilibrium distribution of institutions. In this case, unlike in our previous result, the shift in institutional types does not reduce efficiency. It does, though, also have a large impact on the distribution of cultural traits.

Our findings all rest on the interdependence of institutional choices and cultural capacities. An extensive literature demonstrates that culture influences institutional performance and, therefore, institutional choices. (Alesina and Guilano 2015). Historical analyses, most notably Putnam's (1993) study of social capital in Italy, reveal how similar institutions can perform differently depending on the context. Efforts by international institutions to create well functioning markets generally fail (Easterly 2017). To be successful, markets require that the countries in which they operate to support strong property rights, and a common belief in a currency or other means of non-bartered trade, along with acceptance of accountability mechanisms, generally state-reliant, to make long-distance, impersonal trade possible (Milgrom, North, and Weingast 1990, Lipset 1959, Lipton and Sachs 1990). In contrast, hierarchies require high levels of trust within the authority based networks of the organization. (Banerjee et al 2013).[2]

The concept of culture has no generally accepted definition. In fact, it suffers from too many definitions. Culture includes artifacts, values, toolkits, beliefs, religion, rituals, knowledge, behaviors, norms, and networks. Here, we focus our analysis on those aspects of cultural that most contribute to institutional performance, and employ the term *cultural capacity* to capture them. Cultural capacity includes human capital and technological capacity (Hidalgo and Hausmann 2009), social capital (Putnam

[2]A significant empirical literature documents that culture influences institutional outcomes (Guiso, Sapienza and Zingales 2006). Gorodnichenko and Roland (2021) find individualism influences institutional performance but weaker effects of institutions on individualism. Disentangling the joint effects can be difficult at the country level (Michalopoulos and Papaioannou 2014).

1993), behavioral repertoires (Dolan and Galizzi 2015, Henrich et al 2001, 2004), toolkits (Swidler 1986), belief systems (Ingelhart 1997), network structures (Jackson, Rogers, and Zenou 2017), bounds on human cognitive capacity (Simon 1997), logics of appropriateness (March and Olsen 2004), strategies in games (Bednar and Page 2018), and the distribution of knowledge (Hayek 1945, Chwe 2003, Easterly and Easterly 2006).

Of course, cultural effects do not deny that the success of a market, democracy, or hierarchy also depends on their design and context (Arrow 1974, Ostrom 2009). Markets will typically be better at allocating private goods than democracies or hierarchies (Sah and Stiglitz 1988). Often, though, no one institution will be necessarily best. Consider the integration of refugees. A society could just allow markets to function, it could rely on the government to build a bureaucratic mechanism, or it could even rely on an algorithm to assign people to communities (Ahani et al 2021). The success of each of these institutions will in part depend on cultural capacity. A community-based institution relying on informal norms may perform well in a high trust society with sharing behaviors and a highly connected social network. It may perform less well in a low trust society with predominantly self-interested behaviors and a status based social network (Bicchieri 2006). A market based solution would likely require high levels of generalized trust, norms of reciprocity and strong social networks as well as specialized knowledge in order to succeed.

Our systems approach also assumes that institutions build cultural capacities. North (2005) makes a similar claim when he describes how the "institutional matrix" creates incentives and an informational context that steers the allocation of skills and knowledge. Many other scholars describe how cultural attributes, including levels of trust, individualism, and cooperation, depend on the mix of institutions (Tabelini 2008, Aghion et al 2010). Markets, for example, can build acceptance of rule of law, property rights, and contractual commitments. These are all components of cultural capacity.

This paper belongs to a theoretical literature exploring the interplay between institutions and culture. Other papers emphasize how interdependence produces multiple equilibria through path dependence (Grief and Laitin 2004, Crouch and Farrell 2004), and how institutions change beliefs and behaviors (Bednar and Page 2007). These papers show how one society might evolve high levels of trust and low levels of regulation, while another might fail to build trust and then have to rely on regulation (Bisin and Verdier 2021). These models, for the most part, consider the interdependence between institutional choices and a specific cultural trait such as cooperation or trust. Here, we take a more abstract systems approach and consider multiple types of interdependencies (Meadows 2009). Our approach reveals the

aforementioned tension between the production and utilization of cultural capacity. A society prefers institutions that produce cultural capacity, but it only benefits from that capacity if it selects institutions that utilize it. By taking a high level systems approach, we can explore the implications of different types of interdependencies.

Our initial model of markets, hierarchies, and democracies. Later, we add community-based institutions and algorithms. By a community based institution, we mean a collective that makes a decision, manages a common pool resource (Ostrom 2009), or allocates resources through norms and rules. Jung and Lake (2011) rely on a similar construct that they call networks. By algorithms, we mean information based procedures that rely on computer algorithms. Some algorithms, such as those used to allocate organs (Ergin, Sonmez, and Unver 2017), match medical residents to hospitals, students to schools, or identify potential life partners or dates, require active involvement of participants. Others, such as an algorithm that assigns road crews to repair potholes based on satellite images, require no active human involvement.[3]

Our formal model assumes a collection of domains that require an institutional choice. A domain might be the allocation of land or the provision of health services. In each domain, the society selects the highest performing institution. This is consistent with models from the mechanism design literature which takes the cultural context as fixed (Maskin 2008, Myerson 2008, Page 2012).[4] We assume that domains arrive and institutions are chosen in sequence. As choices are made and institutions place in operation, the cultural capacity changes and this influences future institutional choices. Our model traces out the dynamic, interdependent paths of the institutional ensemble chosen and the cultural capacities it produces.

Types of Interdependence of Institutions and Cultural Capacity

To build intuition, we first describe three types of interdependencies between cultural capacity and institutions: *positively reinforcing interdependencies*, *negative spillovers*, and *generic capacity building*. and institutional performance. We later build computational models for each, but for now, our purpose is to provide some examples of what cultural capacity is, how it can effect institutional performance,

[3] Alternatively, one could assume algorithms make each type of institution more effective but in different ways (Malone 2018). That assumption would require different assumptions than ours but might well produce qualitatively similar results on the effect of algorithms on democracy and self-organized communities.

[4] We do not consider the inclusion of informational and computational costs(Hurwicz and Reiter 2006) or the robustness of the outcomes implemented (Borgers 2018).

and how institutions can, in turn, build those capacities.

Recall, that we take an encompassing view of cultural capacity and take it to include those parts of culture that influence institutional performance. Our conception includes, but is not limited to behaviors, beliefs, values, toolkits, networks, logics of appropriateness, as well as the distribution of information. These features of a society affect institutional performance, therefore, they will also affect institutional choices. We do not deny that powerful actors may drive institutional choices toward those types that benefit themselves and not society at large. Our model could easily be expanded to accommodate capture by powerful actors. To derive their effect, we first need the benchmark case where no distortion exists, so we start there.

Positively Reinforcing Interdependencies

Positively reinforcing interdependencies exist when specific types of cultural capacity benefit a single institutional type and that institutional type, in turn, builds more of that cultural institutional capacity. Often referred to as positive feedbacks, positively reinforcing interdependencies are used to explain institutional path dependence (Pierson 2004). Positively reinforcement is also implicit in Kranton (1996), which shows how reciprocal exchange creates an incentive to form networks with likely trading partners. Those networks become a type of cultural capacity that makes reciprocal exchange more efficient, leading to more reciprocal exchange. In the model, markets also have positively reinforcing culture capacity. Markets rely on people meeting at sites where commodities are traded impersonally. As more people participate in markets, market transactions become more efficient.

Positive reinforcement can also arise through beliefs (Grief and Laitin 2004) or in behaviors (Bednar and Page 2018). Figure 1 shows how markets, hierarchies, and democracies could all produce positively-reinforcing feedbacks with specific behaviors. At the top of the figure are three behavioral cultural traits. The first, *risk taking*, correlates with cultural measures of individualism in cross cultural studies of the insurance and banking industries (Gaganiss et al 2019, Mourouzidou-Damtsa, et al 2019). The second, *rule following*, refers to the propensity to adhere to informal laws as well as informal norms. The tendency to follow rules and punish violators a component of *tightness-looseness* measures of culture (Gelfand et al 2011).[5] The third behavioral cultural trait, *collaborating* corresponds to the ability to the ability to work effectively across differences.

[5]Variation on tightness-looseness proved crucial for the success of COVID policies. A pre-registered global analysis using controls found that all else equal the loosest countries had five times the number of cases of COVID and nearly nine times the number of deaths (Gelfand, Jackson, Pan et al 2021).

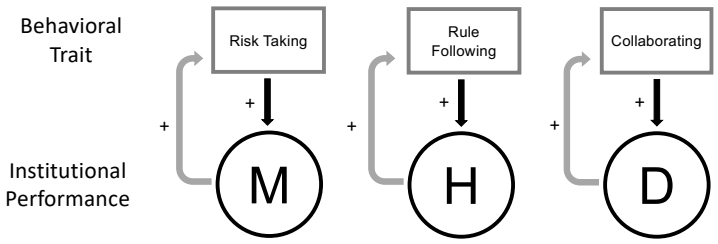

Figure 1: Positively Reinforcing Cultural Institutional Interdependence

The black arrows with the plus (+) signs denote that increases in each of those behavioral traits improve the performance of the corresponding institutional types. Rule following behaviors, for example, make hierarchies perform better. Here, we assume that they have no effect on markets or democracies. Similarly, the ability to collaborate and the willingness to take risk improve the performances of democratic and market institutions respectively.

This figure represents one of many possible examples of positive reinforcement as evident from descriptive accounts of feedbacks (Pierson 1994). We note that one can even adapt models of behavioral attention (Gabaix 2019) to produce self-reinforcement on institutional types. If we assume that people have limited attention to spread across institutions, and if institutions of the same type oblige that attention be allocated to similar stimuli, this too will produce self-reinforcement of institutional types (Jung and Lake 2011). Markets, for example, create incentives for people to allocate their attention to information relative to the markets in which they operate. A fruit grower follows weather reports and fuel prices but pays less attention to social issues and political issues. In few people pay attention to those issues, democratic institutions may not perform effectively.[6]

[6]Relatedly, countries that rely primarily on market institutions may promote individualism and produce generalized, as opposed to reciprocal trust (Alesina and Giuliano 2015).

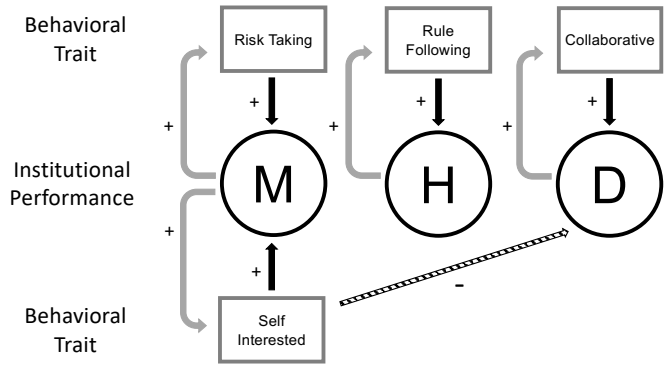

Figure 2: Negative Spillovers from Markets through Self-Interested Behavior

Negative Spillovers

We next consider negative spillovers. When this occurs, an institution builds a cultural capacity that hinders some other institutional type or types. Figure 2 shows one such example. The figure incudes two positively reinforcing interdependencies between markets and cultural behaviors. Markets build risk taking behavior and self interested behavior. In turn, both of these behaviors improve the performance of markets. Implicit in the diagram is an assumption that risk taking behavior does not impact other institutions, but that self-interested behavior does. It reduces the efficacy of democracies which benefit from people exhibiting other regarding behaviors.

To make the negative spillover even more explicit, one might draw a similar diagram linked to Hofstede's (1980) cultural dimensions and replace self interested with individualism and replace collaborative with collectivism. Hofstede considers these traits as in opposition. A person can be individualist or collectivist. If markets make people more individualist, they necessarily make people less collectivist.

Generic Capacity Building

Last, we consider the possibility that institutions could build *generic* civic capacity. Here, we have in mind something like trust in institutions generally as shown in figure 3, In the diagram shown, democracy builds trust which then improves the performance of all three institutional types. This could happen through the production of common knowledge of beliefs in the institutions - you know that I know that

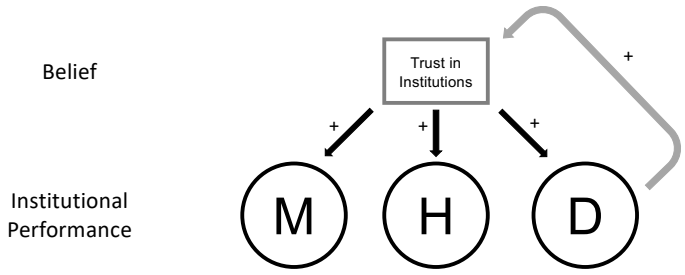

Figure 3: An Example of Generic Cultural Capacity Building

you trust the law (Chwe 2003). Trust could also be built through other regarding preference creation (Bowles 1998). People who care about one another may be more likely to trust one another. If trust in the law, leads to trust in contracts, property rights, and trust that other people will keep promises, then markets and hierarchies would also benefit from the trust built by democracies.

In the diagram, only democracies build generic trust. Markets and hierarchies do not. We are not making an empirical claim that this is the case. In fact, one of our early mathematical results will assume that all three types of institutions build generic cultural capacity. For example, markets build dyadic trust relationships through exchange of goods and services. Those relationships may well be robust across institutional types. Trust in a market setting would extend to trust in non market settings.[7]

To be clear, we do not intend for these three types of interdependencies to be exhaustive. Cultural capacity has many components. These diagrams show just a few. And, these diagrams oversimplify institutions. Markets, hierarchies, and democracies can all take many forms. Any empirical treatment would have to consider the interdependence of cultural capacity with the particular features of of institutions. Ostrom (1990), elaborates design principles for institutions that manage common pool resources.[8] Some of these require, notably monitoring and and dispute resolution, require significant levels of trust and common knowledge.

[7]Evidence supports that claim. Bridging ties across ethnic groups created in markets may reduce ethnic conflict (Varshney 2002).

[8]Ostrom's eight design principles are (1) Clear group boundaries. (2) Match rules to local needs and conditions. (3) Allow modification of rules by the community. (4) Acceptance by external authorities. (5) Monitoring. (6) Graduated sanctions. (7) Dispute resolution. (8)Nested levels of governing.

A Systems Framework

Our framework rests on three assumptions: First, that nations or communities rely on *ensembles* of institutions to allocate resources, establish rights, and make other decisions; Second, that the performance of those institutions depends on levels of *cultural - institutional (CI) capacity*; Third, that each institutional type produces cultural capacity differently. Markets may produce relatively self-interested behavior, specialized information, and networks based on resources and information. Democracies may produce other focused behaviors, generalized information, and networks based on shared interests.

The latter two assumptions create an interdependence between cultural capacity and institutional ensembles. Institutional choices, and therefore, the ensemble composition depend on cultural capacity and cultural capacity depends on the composition of the ensemble. It will be helpful to think of cultural capacity and institutions as operating as a discrete time dynamical system. In each period, a new allocative or decision domain arises, and society must choose an institution. That institutional choice will change the levels of cultural capacity. These changes in cultural capacity alter the performance of existing institutions and likelihood of choosing the various institutional types in the future. Our analysis focuses on the equilibria of this dynamical systems. An equilibrium will consist of an ensemble of institutions along with levels of cultural capacity that are mutually consistent in a way we make formal below.

We represent ensembles, E, as probability distributions over a set of N institutional types. These types can represent broad categories such as markets, hierarchies, and democracies, or they can can be more granular and represent matching markets, two-sided auction markets, participatory democracy, or matrix structured organizations.

An **institutional ensemble**, *$\vec{e} \in E$, is a probability distribution defined over a set of N institutional types.*

We represent cultural capacity as a K dimensional vector. This formalism captures attributes that map into numerical values like trust or even aggregate variables (Inglehart. 1997) It could even capture features of networks through statistics such as average degree and clustering coefficients. This formalism though may be less adequate for representing toolkits (Swidler 1986) and cognitive conceptions of culture (Dimaggio 1987).

cultural capacity, $\vec{c} \in C$ is a k-dimensional weakly positive real valued vector.

Our model rests on two central assumptions. First, that cultural capacity levels depend upon the composition of the institutional ensemble.

A **cultural capacity function**, $G : E \rightarrow C$ *maps institutional ensembles into cultural capacity levels.*

Second, that the ensemble composition depends on cultural capacity levels. The causal mapping requires elaboration. An ensemble consists of a large number of institutions and that those institutional choices accrued over time. In each choice instance, the performance of an institutional type depends on cultural capacity. It also depends on the *context*. Some contexts may be well suited to one type of institutions and others suited to other types. Markets perform well at allocating consumer products but are less effective for determining the guilt or innocence of alleged criminals. Hierarchies can effectively manage complex production process but do a poor job of choosing vacation destinations for a population.

A **context**, $\vec{\theta} \in \Theta$ is a N dimensional weakly positive real valued vector that characterizes how well each institutional type performance in a given instance. Contexts are drawn from a distribution $\mathcal{F}(\vec{\theta})$.

This formalism allows us to write the expected institutional performance as a function of cultural capacity and context.

An **institutional performance function:** $V : C \times \Theta \rightarrow \Pi$, *where* $\Pi = [0, \infty)^N$ *gives the* realized performance, $(\pi_1, \pi_2, \ldots \pi_N)$, *of each institutional type given cultural capacity and a context.*

We next specify an institutional choice rule that selects the institutional type as a function of these realized values.

An **institutional choice rule** $\Gamma : \Pi \rightarrow E$ *chooses a distribution across institutional types as a function of their payoffs.*

In what follows, we assume that this rule chooses the type with the highest realized type. This may overstate the performance of the mechanisms used to select institutions in the real world. A more realistic assumption might be that types are chosen with probabilities that depend on their relative performances. We might assume instead a discrete choice model that includes randomness (McFadden 1974).

Given this construction, we can define equilibria of these systems as consisting of cultural capacity levels together with an ensemble such that two conditions hold. First, the cultural capacity levels are

those produced by the ensemble, and, and second, the ensemble's composition is what would result from the institutional choice rule applied to the cultural capacity levels.

Given a cultural capacity function, G, an institutional performance function, V, a distribution over contexts, $\mathcal{F}$, and an institutional choice function Γ, *an* **ensemble institutional capacity equilibrium (ECI)** $(\vec{e^*}, \vec{c^*})$ *satisfies the following conditions:*

(i) $\vec{c^*} = G(\vec{e^*})$

(ii) $e_i^* = \text{Prob}[\Gamma(V(\vec{c^*}, \vec{\theta}) = i \mid \mathcal{F}]$ for $i \in \{1, 2, \ldots N\}$

When convenient, we denote an ECI equilibria by the institutional ensemble, $\vec{e}$, rather than the ensemble, cultural capacity pair. We will focus primarily on these equilibria.

1 Market, Hierarchy, Democracy Models

Our first classes of models consider the three most common institutional types: *markets, hierarchies,* and *democracies* We denote an ensemble by its proportions of markets (m), hierarchies (h), and democracies (d). For ease of interpretation, we represent cultural capacity with respect to institutional types. Thus, we write cultural capacity as (c_m, c_h, c_d), where c_m corresponds to the cultural capacity relevant to markets.

To derive closed form solutions, we write the performance of an institution of type i as the product of the relevant cultural capacity and contextual fit, θ_i, which we assume to be drawn from a uniform distribution over the unit interval. Formally, $V_(\vec{c}, \vec{\theta}) = c_i\theta_i$, where θ_i is drawn independently from an i.i.d. uniform distribution on $[0, 1]$ [9]

In a given choice instance, the institutional type with the highest realized value is chosen. That value depends on both contextual fit and cultural capacity. Given our assumption that contextual fit is a random variable, this produces a probability distribution over the institutional types.

We assume for the moment that the cultural capacity for democracies is highest and for markets is lowest ($c_m \leq c_h \leq c_d$). Given that we have yet to introduce any asymmetries, this does not effect the analysis. Our first claim describes the likelihood of choosing each institutional type as a function of cultural capacity levels given that assumption.

[9] Were we to assume a truncated normal distribution, our results would not change qualitatively.

Claim 1 *Assuming uniform distributions over contextual fit, given cultural capacity* (c_m, c_h, c_d)*, with* $c_m \leq c_h \leq c_d$*, the probabilities of choosing institutional types are as follows:*

$$(m, h, d) = \left(\frac{2c_m^2}{6c_h c_d}, \frac{3c_h^2 - c_m^2}{6c_d c_h}, \frac{6c_d c_h - 3c_h^2 - c_m^2}{6c_d c_h} \right)$$

This claim has two straightforward implication. First, if all three types of institutions have identical civic capacity, then each type if chosen with equal probability. Second, recall that we assume markets have the lowest level of cultural capacity. If that were to be zero, markets would never be chosen in equilibrium. A less straightforward corollary gives the expected performance of institutions.

Corollary 1 *Given an ensemble* (m, h, d) *that produces cultural capacity* (c_m, c_h, c_d)*, with* $c_m \leq c_h \leq c_d$*, the expected performance of institutions chosen:*

$$\frac{9c_m^3 \ + \ (8c_h - 8c_m + 12)(c_h^2 - c_m^2)}{12c_h c_d} \ + \frac{(c_d^2 - c_h^2)}{2c_d}$$

Notice, consistent with intuition, that increases in any of the cultural capacities would increase expected performance. This derivation will become important later when we prove the inefficiency of equilibria.

1.1 Generic Cultural Capacity

We next consider the case of generic cultural capacity, such as the aforementioned trust in institutions. We denote this by c_g. We assume that the cultural capacity for each institutional type can be described by a *utilization parameter*, λ_i, times c_g. Thus, $(c_m, c_h, c_d) = (\lambda_m, c_g, \lambda_h c_g, \lambda_d c_g)$. We further that each institutional type produces capacity at a fixed rate, with γ_i denoting the rate at which institutional type i produces c_g. It follows that $c_g = \gamma_m m^* + \gamma_h h^* + \gamma_d d^*$. The γ_i's are *production parameters*. They capture how much trust each institution produces.

We can then write the institutional performance function $V(c, \vec{\theta}) = (\lambda_m \theta_m c_g, \lambda_h \theta_h c_g, \lambda_d \theta_d c_g)$ where $\lambda_i \in [0, 1]$ for $i \in \{m, h, d\}$. It follows that in equilibrium, the prevalence of each institutional type in equilibrium only depends on the utilization parameters. It does not depend on the production parameters as shown in the next claim.

Claim 2 *Assuming one-dimensional cultural capacity with production and utilization parameters* $\vec{\gamma}$ *and* $\vec{\lambda}$*, with* $\lambda_m \leq \lambda_h \leq \lambda_d$ *an ECI equilibrium can be written as follows:*

$$(m^*, h^*, d^*) = \left(\frac{2\lambda_m^2}{6\lambda_h\lambda_d}, \frac{3\lambda_h^2 - \lambda_m^2}{6\lambda_h\lambda_d}, 1 - \frac{3\lambda_h^2 + \lambda_m^2}{6\lambda_d\lambda_h} \right) \qquad c_g^* = \gamma_m m^* + \gamma_h h^* + \gamma_d d^*$$

The implication, though clear within the model, merits emphasis. Institutions are chosen based on how well they perform. That is determined by how effectively they *utilize* cultural capacity. Performance evaluations do not take into account how much cultural capacity an institution *produces*. Thus, as we make formal in a later claim, we should not expect efficient ensembles.

Cultural capacity production will matter though for expected performance as shown in the next claim.

Corollary 2 *Assuming one-dimensional cultural capacity with production and utilization parameters $\vec{\gamma}$ and $\vec{\lambda}$, the expected performance of an ECI equilibrium $(m*, h^*, d^*, c^*)$ equals:*

$$(\gamma_m m^* + \gamma_h h^* + \gamma_d d^*) \left(\frac{9\lambda_m^3 \ + \ (8\lambda_h - 8\lambda_m + 12)(\lambda_h^2 - \lambda_m^2)}{12\lambda_h\lambda_d} \ + \frac{(\lambda_d^2 - \lambda_h^2)}{2\lambda_d} \right)$$

This corollary reveals a tradeoff between choosing institutions that produce cultural capacity and choosing those that utilize it.

The **production-utilization tradeoff***: composing an ensemble creates a tradeoff between selecting institutions that best utilize cultural capacity and those more effective at producing it.*

Recall that in each context, society chooses the institutional institutional type that maximizes performance. An implication of claim 2 is that an ECI equilibrium ensemble does not depend on the production parameters. It follows that the equilibrium will only maximize expected performance in rare cases.

Corollary 3 *Assuming one-dimensional cultural capacity with production and and utilization parameters $\vec{\gamma}$ and $\vec{\lambda}$, the institutional type that produces the highest performance need not maximize the performance of the ensemble.*

The proof of the corollary relies on an example. Suppose that markets produce cultural capacity but that hierarchies do not, $\gamma_m = 1$ and $\gamma_d = 0$ and that in a context a hierarchy produces higher performance than either a market or a democracy but that the performance of the market is arbitrarily close to that of the hierarchy. Choosing the market improves the performance of every other institution by an amount equal to γ times the production parameter of that institution. Thus, if the performance

difference between markets and hierarchies is sufficiently small, the market would be the better choice.[10]

1.2 Self Reinforcing Interdependence

We now return to what might be considered the canonical case of self reinforcing interdependence described earlier. The assumption here is that each institutional type build cultural capacity that makes its type, and only its type, more effective. A special case of this was shown in figure 1 in which markets promoted risk taking, hierarchies promoted rule following and democracies promoted collaborating.

In the analysis that follows, we distinguish among three types of ensembles: *homogeneous ensembles* in which all institutions are of the same type; *equal representation ensembles* in which all three types of institutions are equally likely and *type predominant ensembles*, where one institution is more prevalent than the other two, and those two exist in equal proportions.

Initially, we assume that all institutional types build cultural capacity according to the same function. We can then state a result characterizing conditions for equal representation and homogeneous ensembles to be stable ECI equilibria. If increases an institutional type do not produce much cultural capacity for that institution, that is if $G'()$ is small, then the equal representation ensemble will be an equilibrium. If, on the other hand, $G'()$ remains large even when all institutions are of one type, then only the homogenous ensembles will be stable.

Claim 3 *Assume that each institutional type builds cultural capacity only for its own type according to the same function;* $(G(m), G(h), G(d))$ *where* G *is weakly concave, differentiable, nonzero and* $G(0) = 0$*,then the following hold:*

(i) the equal representation ensemble is a stable ECI equilibrium if and only if

$$G'\left(\frac{1}{3}\right) < G\left(\frac{1}{3}\right)$$

.

(ii) homogeneous ensembles are stable ECI equilibria if and only if

$$2G(1) > G'(0)$$

[10] Were we to assume instead an institutional choice rule that takes into account of how the production of cultural capacity improves performance of existing institutions, that would improve performance but still not be optimal as it does not take into account the expected increase in performance of future institutional choices.

So that we can derive explicit comparative statics results, we restrict attention to specific family of convex cultural capacity functions: $G(m,h,d) = (m^\beta, h^\beta, d^\beta)$ where $0 \leq \beta \leq 1$ for which proportional cultural capacity building,($\beta = 1$), is a special case. The parameter β is key to what follows. At $\beta = 0$, institutional performance does not a tall depend on the ensemble's composition, so only the equal representation ensemble will be an ECI equilibrium. For small values of β, a small amount of cultural capacity for any institutional type will be sufficient for the institution to perform at near full efficacy. Fo example, if $\beta = 0.05$, then if only ten percent of institutions were markets, markets would still perform at 90% percent of their full efficiency. If, though, $\beta = 1$, and only ten percent of institutions were markets, the markets would only perform at 10% percent of their full efficiency. We will therefore refer to β as the *sensitivity* to cultural capacity. When β is high, institutions are sensitive to reductions in cultural capacity.

Claim 4 characterizes ECI equilibria as a function of the parameter β. When institutions are insensitive to cultural capacity levels, all institutions have equal representation. When sensitivity exceeds a threshold, $\beta > \frac{1}{3}$, the equal representation ensemble is no longer a stable equilibrium and three equilibria emerge, each with a single dominant institution. In the limit, as the cultural capacity function for each institutional type equals the proportion of institutions of that type, the only equilibrium consist all institutions of the same type.[11]

Claim 4 *If $G(m,h,d) = (m^\beta, h^\beta, d^\beta)$, the following hold:*

(i) If $\beta < \frac{1}{3}$, the equal representation ensemble *is the unique stable EIC equilibrium.*

(ii) if $\beta \in (\frac{1}{3}, 1)$, the EIC equilibria ensemble include institution predominant ensembles*:*
$\{(x,x,y),(x,y,x),(y,x,x)\}$ *where $y > x$, satisfies* $3y^\beta \cdot (1-y)^{1-\beta} = 2^{1-\beta}$

(iii) if $\beta = 1$ the homogenous ensembles*: $\{(1,0,0),(0,1,0),(0,0,1)\}$ are the only stable EIC equilibria.*

Note that as β increases, as institutions become more sensitive to cultural capacity levels, the proportion of the dominant institution increases.[12]

Figure 4 shows the dynamics produced by the three classes of cultural capacity functions as a function of β. In in early periods the ensemble has more markets than hierarchies and more hierarchies than

[11] In dynamical systems theory, this is known as a *pitchfork bifurcation.* A graph of the equilibria as a function of β consists of a single line up to the threshold, and then it splits into multiple prongs resembling a pitchfork.

[12] The proportion converges to one as β approaches one, so the system has no discontinuity.

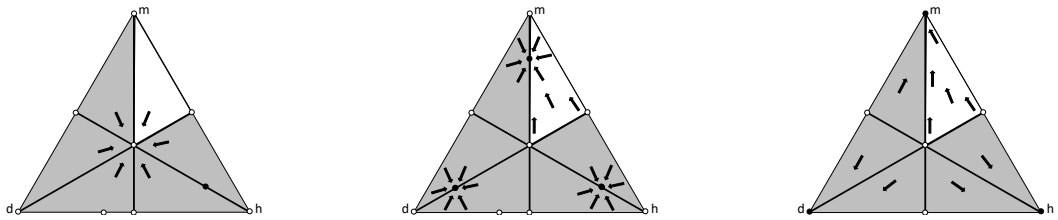

Figure 4: Dynamics for Low, Moderate, and High Sensitivity to cultural capacity

democracies, the distribution will lie in the white region in all three diagrams. If sensitivity to cultural capacity, β, is low, the left diagram, the path of initial construction will not matter. In the long run, the ensemble will consist of equal levels of each institutional type.

In the middle and right diagrams, the path of institutional choices matters for the equilibrium. Early on in the process of constructing an ensemble, each institutional choice has a large effect on the composition. If democracies were to perform well in a sequence of contexts, the ensemble could move out of the white region and into the basin of attraction for the equilibrium in which democracies predominate. Later on, as the ensemble consists of more institutions, basin jumping is less likely to occur. Eventually, it will never occur. The ensemble will converge to the equilibrium in the white region. These systems exhibit *early path dependence* (Page 2006) and eventually *lock-in* to an equilibrium (David 1985)

In the generic, one-dimensional, CI model, the ECI equilibria were inefficient because choices ignored the production of cultural capacity. With self-reinforcing CI, institutional choices build the desired type of cultural capacity. If democracies predominate, then choosing democracies builds the cultural capacity to improve their performance. This would seem to produce efficient ensembles. However, while all ECI equilibrium are stable, only the homogeneous and equal representation ensembles maximize expected performance.

Corollary 4 *If $G(m,h,d) = (m^\beta, h^\beta, d^\beta)$, the only stable ECI equilibrium that maximize expected performance are the homogeneous ensembles and the equal representation ensembles.*

The proof reveals that that institution predominant ECI have greater institutional diversity than optimal. For intuition as to why this is the case, first note that a homogenous ensemble's single institutional type has a cultural capacity level of one implying that the ensemble has an expected realized payoff of one-half. For moderate sensitivity, equilibria ensembles produce relatively low levels of cultural

capacity for the non dominant institutions. For the case of $\beta = \frac{1}{2}$, the democracy dominant ensemble equals $(\frac{1}{6}, \frac{1}{6}, \frac{2}{3})$, this produces cultural capacity levels of approximately 0.4 for markets and hierarchies and of approximately 0.8 for democracies. In this example, if the contextual fit of democracy exceeds one-half, a democracy will be chosen, and the expected performance will equal 0.6. Conditional on the contextual fit of democracy being less than one-half, each institution is equally likely to be chosen, so the expected performance, equals 0.3.[13] The average of 0.3 and 0.6 is less than one-half.

The inefficiency of the equal representation ensemble when $\beta = \frac{1}{3}$ the equal representation ensemble produces cultural capacity greater than three-fourths.. In that case, the expected value of the best contextual fit among all three types equals three-fourths, and the expected realized payoff exceeds one-half.

We next analyze a situation in which one type of institution produces more cultural capacity than the others. This might occur if advances in information technology make markets relatively more efficient. In what follows, we assume that cultural capacity for markets increases by a multiple, $\Delta > 0$. The equilibrium proportion of markets in the market dominant ensemble will then increase by a function of this multiplier. That is to be expected because there is an amplifying loop. Markets are more efficient, so they are more prevalent, which in turn makes them more efficient. Contrary to what might be thought, that the extent of the increase decreases in the level of sensitivity to cultural capacity, β.

Claim 5 *Let $G(m, h, d) = ((1 + \Delta)m^\beta, h^\beta, d^\beta)$, the proportion of markets in the market dominant equilibrium, m_Δ satisfies the following equation:*

$$\frac{2^{1-\beta}}{3(1+\Delta)^\beta} = 3(1 - m_\Delta)^{1-\beta} m_\Delta^\beta$$

implying that m_Δ increases in the cultural capacity multiplier, Δ, and that the magnitude of the increase decreases in β.

The decreasing marginal effects on the proportion of markets as a function of sensitivity requires some unpacking. The amount of the decrease correlates inversely with the increase in the effect of the multiplier implying that increasing the multiplier has more of an effect when sensitivity increases. However, the right hand side of the equation becomes more concave as sensitivity increases. This implies that the proportion of markets in equilibrium increases in sensitivity, meaning less room for markets to

[13] This situation can be treated as if all three types have cultural capacity of 0.4. The best of three draws of contextual fit has an expected value of $\frac{3}{4}$.

increase. These two effects dominate. Therefore, higher levels of sensitivity produce smaller increases in the equilibrium proportion of markets holding the size of the cultural capacity multiplier fixed.

This can be seen figure 5. The horizontal access represents the proportion of markets. The origin of the graphs corresponds to the diverse ensemble. The dashed line corresponds to the value of the left hand side of the equation in the baseline case ($\Delta = 0$). The grey line shows the value of the left hand side given a cultural capacity multiplier for markets ($\Delta > 0$). The addition of the cultural capacity multiplier produces a downward shift because the left hand side equals a constant times the inverse of the multiplier effect. Note that the relative effect size increases in the level of sensitivity.

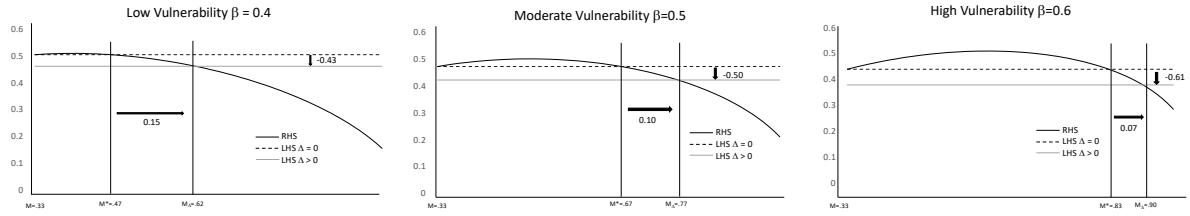

Figure 5: cultural capacity Multiplier Has Larger Effect for Low Sensitivity cultural capacity

The solid black curve corresponds to the right hand side of the equation. As sensitivity increases, the curve becomes more concave as a function of the proportion of markets. This occurs because the marginal benefit of adding more markets from the diverse ensemble increases. And, as already shown, the equilibrium proportion of markets (in the market dominant equilibrium) increases in sensitivity. As evident from the figure, for higher levels of sensitivity, the term on the right hand side has a steeper slope implying that a decrease in the proportion of markets produces a larger decrease in value. The change in slope is sufficiently large that, on net as shown by the horizontal arrows, the change in the proportion of markets in equilibrium *decreases* rather than increases as institutions become more sensitive to cultural capacity.

1.3 Generic And Self-Reinforcing Cultural Capacity

We now add generic, one-dimensional cultural capacity, c_g, to our model with self-reinforcing IC capacity. As before, we assume linear production and utilization of the one-dimensional cultural capacity. We first consider the case in which only democracy builds cultural capacity for the other two institutional types and does so at rate $\lambda \in [0, 1]$. To make the closed form solutions more interpretable, we assume

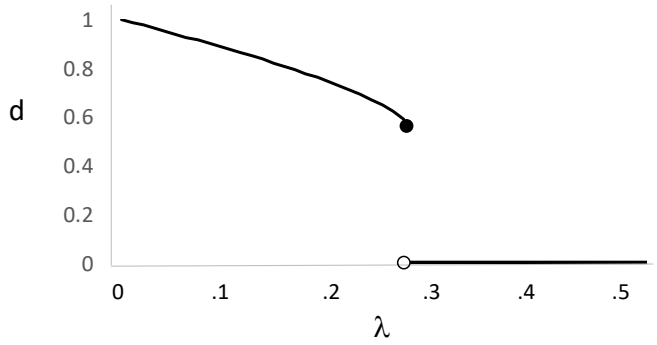

Figure 6: Collapse: Democracies as Function of Generic cultural capacity Building

proportional cultural capacity building.

For low levels λ, the democracy predominant ECI equilibrium exists. However, once the production parameter, λ, exceeds a critical threshold $\bar{\lambda}$, at which the generic cultural capacity equals approximately one-fourth of the institutional specific effects, then the democracy predominant equilibrium collapses as shown in figure 6. Above the critical threshold, the only equilibria consist of entirely hierarchies or entirely markets. This is an extreme form of the production-utilization tradeoff.[14]

Claim 6 *(Paradox of cultural capacity Building) If* $G(m, h, d) = (m + \lambda d,\ h + \lambda d, d)$*, where* $\lambda \in (0, 1]$*, then there is a critical value* $\bar{\lambda} = (2 - \sqrt{3})$*, such that if* $\lambda < \bar{\lambda}$*, there exists a democracy predominant ensemble equilibrium. If* $\lambda > \bar{\lambda}$*, the only stable equilibria are homogenous ensembles consisting of markets or hierarchies. At* $\bar{\lambda}$*, the proportion of democracies equals* $\frac{\sqrt{3}}{2}$*, which implies a collapse of the the democracy predominant equilibrium.*

Though the paradox of cultural capacity building calls to mind the democratic backsliding literature (Flores and Nooruddin 2016, Levitsky and Ziblatt 2018), the causal logics differ in two ways. First, the logic of the paradox applies to any institutional type that builds significant cultural capacity for other types. We make no special claim that it might only apply to democracies. Second, the paradox of cultural capacity building arises because democracy builds capacity for the other institutional

[14]The logic underlying this collapse differs from that of democratic backsliding (Flores and Nooruddin 2016, Levitsky and Ziblatt 2018). Democratic institutions become less prevalent not because they are less efficient. In fact, they become more efficient, but relatively less effective when compared with other institutions.

types. Democratic institutions become less represented because other institutions become relatively more effective In democratic backsliding, democracies become less effective in an absolute sense.

1.4 Complementary and Directional Civic Capacity Building

We now extend our framework to include two other types of institutions: *self-organized communities* and *algorithms*. We denote an ensemble as a probability distribution over these five types of institutions as (m, h, d, s, a). We do so in order to construct and analyze more elaborate cross institutional spillovers. Recall that by self-governing collectives, we mean informal institutions that rely on norms (Ostrom 2009), and that by algorithms, we mean protocols that aggregate information, take actions, or allocate resources with either no direct human involvement or minimal information transfer.

We define a *complementary* cultural capacity interaction to arise when two institutional types each build cultural capacity for one another, and *directional* cultural capacity building to occur when one institution produces cultural capacity for another. For example, democracies and self-organized communities might both building general knowledge and other regarding information acquisition strategies. Or, markets and algorithms might both encourage accumulation of specialized knowledge useful in algorithms. These would both be examples of complementary cultural capacity building. Democracies might also produce trust that markets can utilize, but markets might not produce any cultural capacity relevant for democracies.

In what follows, we assume self-reinforcing cultural capacity building for each institutional type and add in directional and complementary cultural capacity building. Our next claim assumes complementary CI capacity building between democracies and self-organized communities, directional cultural capacity building from democracies to markets, and self-reinforcing cultural capacity for all institutional types. We sketch those interdependencies in figure 7. The figure does not show how the different types of institutions bild different types of cultural capacity. A complete figure could show democracies and self-organized communities both building other-regarding behaviors and these behaviors making those two types of institutions more effective.

We formally write cultural capacity function as follows: $G(m, h, d, s, a) = (m+\lambda d, h, d+\lambda s, s+\lambda d, a)$. We assume a single parameter γ so that the complementary and directional cultural capacity building have similar magnitude.

This construction need not imply that the proportion of democracies and self-organized communities must equal in equilibrium. As the next claim states, there is an ECI equilibrium in which democracies

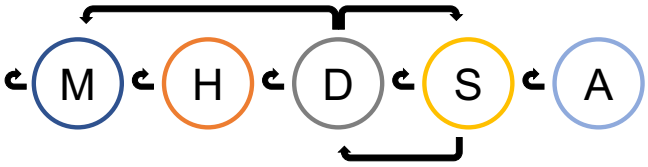

Figure 7: Democratic Spillovers with Self-Organized Community Feedback (Sketch)

predominate and equal proportions of self-organized communities and markets. Such an equilibrium arises because self-organized communities and markets both utilize capacity generated by markets. . As γ, the magnitude of complementary and directional cultural capacity building, increases, the proportions of markets and self-organized communities increase and the proportion of democracies decreases. However, in this case, no collapse occurs. The complementary between democracies and self-organized communities produces a smooth decrease in the proportion of markets as shown in the next claim.

Claim 7 *$G(m,h,d,s,a) = (m+\lambda d, h, d+\lambda s, s+\lambda d, a)$, there exists an ECI equilibrium of the form*

$$(m,0,d,s,0) = \left(\frac{3\lambda}{6-3\lambda}, 0, \frac{6-9\lambda}{6-3\lambda}, \frac{3\lambda}{6-3\lambda}, 0\right)$$

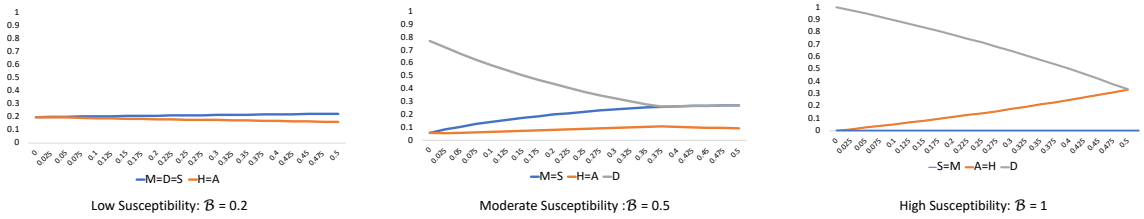

Figure 8: Complementary and Directional cultural capacity Building

The graph on the right of figure 8 plots the democracy and self-organized community predominant equilibrium as a function of γ for proportional self-reinforcing cultural capacity building. As evident from the figure, no collapse occurs. Nor does a collapse occur if we make the institutions more sensitive to self-reinforcing cultural capacity building, by reducing β.

In a final model, we include complementary cultural capacity building between markets and algo-

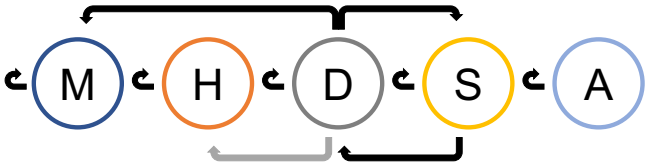

Figure 9: Democracy Spillovers, Self-Organized Community Feedback and Hierarchy Spillover (Sketch)

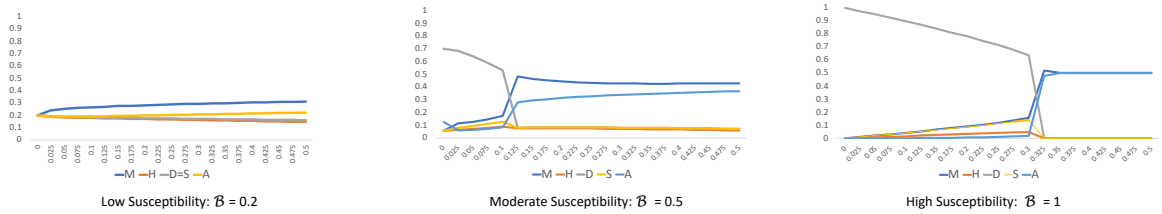

Figure 10: Market-Algorithm Complementaries and Democracy Directional Effect on Markets

rithms and moderate directional cultural capacity building from democracies to hierarchies as sketched in figure 9. The grey line represents the weaker directional spillover from democracies to hierarchies. This figure also omits the explicit map to cultural capacity.

We rely on the following class of cultural capacity functions:

$$G(m,h,d,s,a) = (m^{\beta} + \lambda(d+a), h^{\beta} + \frac{1}{2}\lambda d, d^{\beta} + \lambda s, s^{\beta} + \lambda d, a^{\beta} + \lambda m)$$

We do not state a formal claim for this model. We instead show numerical results in figure 10 for low, moderate, and high sensitivity to self-reinforcing civic capacity. Here, we find that the directional complementary from between markets and algorithms produces a dramatic decrease in the proportion of democracies and self-organized communities unless institutions are not sensitive to cultural capacity. For the case of proportional self-reinforcing capacity, this occurs at $\gamma = 0.3$. Below that level of complementary and directional cultural capacity building, the democracy predominate ECI equilibrium ensemble consists of over 60% democracies. At $\gamma = 0.325$, almost no democracies exist in equilibrium. What happens is that the complementarity between markets and algorithms bootstraps the directional effect from democracies to markets.

2 Discussion

In this paper, we have constructed framework to explore the interdependence between institutional ensembles and cultural capacity from a systems perspective. cultural capacity consists of a mixture of institutionally relevant aspects of culture including beliefs, networks, behavioral repertoires, norms and preferences. Our assumptions are broadly consistent with empirical, historical, and experimental studies that demonstrate causal effects in both directions. Institutions influence culture, and culture contributes to the success of institutions. The theoretical literature underpinning those studies emphasizes self-reinforcing feedbacks that produce multiple equilibria. We can thus expect market dominated societies comprised of self-interested actors along with societies that rely on communities whose encourage collectivist behaviors. These positive feedbacks generally imply some combination of sensitivity to initial conditions and path dependence. Early institutional choices or cultural features lead some societies to one equilibrium and other societies to another.

The systems approach we take here enables us to analyze additional types of interdependencies, including generic cultural capacity building. When we combine generic cultural capacity building with self-reinforcing capacity building, we find the potential for collapse. Paradoxically, an institution that creates a lot of generic cultural capacity undermines itself. This collapse differs markedly from the gradual change seen in other models.

We would not predict an immediate collapse of democracies. Changes in institutions will not be as abrupt as in physical systems because institutional switches occur at a relatively slow time scale.If ,say, democracies were to become better at building trust, two phenomena would likely occur. First, given that democracies now perform worse than say markets, we would expect new institutions to be more likely to be markets and some existing democratic institutions to be replaced by markets. The fact that the system produces a phase transition is still important, because it says that a small change in trust building by democracies could, in the long run, lead to almost no new democratic institutions. More troubling, the average performance of institutions in this new, low democracy ensemble, would be low because the ensemble no longer contains the one institutional type that produces the trust that makes institutions effective.

Our final models expand the set of institutional types to include self-organized communities and algorithms allows for interdependence complementary spillovers between pairs of institutions. They can embed an assumption that collectives and democracies build other regarding behaviors and beliefs and

encourage general knowledge acquisition, while markets and algorithms encourage individualist mind sets and specialized knowledge acquisition. These interdependencies between institutions are indirect. Markets do not create a direct positive effect on algorithms. They do so through through cultural capacity. These models do not produce a collapse of democracies. If we start from the democracy predominant ensemble and increase the level of generic cultural capacity building, we instead see a gradual decline in the proportion of democracies in the equilibrium ensemble. In other words, as democracies build more trust, they do not collapse, but they gradually become less predominant. The positive loop between communities and democracies provides the buffer.

We are careful not to make any empirical claims based on these models, but we do believe that this approach can be helpful in making sense of data by providing alternative hypotheses. Data could show a gradual decline in democracies and a decline in democracy specific cultural capacity. An empirical analysis that ignores the distribution across other institutional types could arrive at the conclusion that democratic backsliding occurs. Our model suggests another possibility. Other institutional types, possibly algorithms, could become better at leveraging trust and be chosen instead of democracies. What appears to be democratic decline is instead a rising tide of all institutional forms in which democracies only perform worse relatively.

A systems perspective can reveal subtleties that are missed by a theoretical focus that considers only the interdependence between culture and individual institutions. One immediate consequence of considering entire ensembles is that it makes clear that choosing optimal institutions in each instance almost surely produces inefficient ensembles for the obvious reason that those choices ignore how institutions produce cultural capacity. By the same logic, making marginal improvements in existing institutions to improve allocative efficiency without an awareness of the effects of those modifications on cultural capacity need not be beneficial in the long run. What looks good at the margin may be bad for the system.

That insight may be particularly germane considering that advances in technology lower transactions costs in favor of market based and algorithmic institutions (Davis 2017). If those institutions do not build the types of cultural capacity that enable democratic and community based institutions to thrive, then technological advances could, in part, undermine democracies and collectives. Algorithms and markets would come to predominate not because they are inherently more efficient but because they encourage self-interested behaviors along specialized knowledge. If so, the past need not be predictive. Claims that government hierarchies outperformed the private sector at developing innovative technologies rest on no

cultural effects shifting that calculus (Mazzucato 2021). Markets might now be more efficient at large projects, such as rocket building and space exploration, but this does not imply that government run bureaucracies not have the potential to be more effective than the private sector were we to build the cultural capacity.[15]

add that our analysis does not consider the institutions themselves as part of a system in which each may serve unique, redundant, and complementary functions (Bednar 2008)

Last, institutions are not castles built in the air but cathedrals resting on civic foundations. Institutions rely upon and produce cultural capacity, and we must consider that as an output. The United Nations Sustainable Development Goals include over two-hundred indices. Many of these overlap with what we call cultural capacity. Levels of education, gender equality, and access to work all influence how well institutions perform. To the extent that institutional choices include these goals, they may achieve a win-win by both advancing goals and building the cultural capacity that enables institutions designed for other goals to perform better. Choosing or designing institutions without considering cultural capacity spillovers runs the risk of building Escher staircases in which a sequence of apparently upward steps produce a downward sloping path (Harstad and Selten 2016).

[15] Though we describe the framework as applying to countries or regions, it applies as well to large organizations which also include a variety of institutional types. A university may decide on tenure democratically, assign offices within a hierarchy, and allocate the use of conference facilities through a market. A for profit business might let the market determine wages, make promotion decisions within a hierarchy, and rely on informal norms among employees for making personal vacation decisions.

3 References

Acemoglu, Daron and James Robinson. 2019. *The Narrow Corridor: States, Societies, and the Fate of Liberty* Penguin, New York, NY.

Acemoglu, Daron and James Robinson. 2023 "Culture, Institutions, and Social Equilibria: A Framework." NBER Working Paper 28832.

Aghion, Philippe, Yann Algan, Pierre Cahuc, and Andrei Shleifer. 2010. "Regulation and Distrust. *Quarterly Journal of Economics* 125 (3): 1015–49.

Alesina, Alberto and Paola Giuliano. 2015 "Culture and Institutions," *Journal of Economic Literature* 53(4): 898-944.

Arrow, Kenneth. 1974 *The Limits of Organization* Norton, New York NY.

Banerjee Abhijit , Arun Chandrasekhar, Esther Duflo and Matthew Jackson 2013. "The Diffusion of Microfinance" *Science* 341 no. 6144.

Bednar, Jenna (2008) *The Robust Federation: Principles of Design.* Cambridge University Press, Cambridge, UK

Bednar, Jenna and Scott E. Page. 2007. "Can Game(s) Theory Explain Culture? The Emergence of Cultural Behavior Within Multiple Games." *Rationality and Society* 19(1):65–97.

Bednar, Jenna and Scott E. Page. 2018. "When Order Affects Performance: Culture, Behavioral Spillovers, and Institutional Path Dependence." American Political Science Review 112(1):82-98.

Bednar, Jenna, Andrea Jones-Rooy, and Scott E. Page. 2015. "Choosing a Future based on the Past: Institutions, Behavior, and Path Dependence." *European Journal of Political Economy* 40(B):312–322.

Bicchieri, Christina. 2006. *The Grammar of Society: the Nature and Dynamics of Social Norms* Cambridge University Press, Cambridge. UK.

Bisin, Alberto, and Thierry Verdier 2021 "On the Joint Evolution of Culture and Institutions: Elites and Civil Society." Working Paper, NYU Department of Economics

Borgers, Tilman. 2015. *An Introduction to the Theory of Mechanism Design* Oxford University Press. Oxford, UK.

Bowles, Samuel. 1998."Endogenous Preferences: The Cultural Consequences of Markets and Other Economic Institutions." *Journal of Economic Literature* 36 (1): 75–111.

Chwe, Michael S-Y. 2003. *Rational Ritual: Culture, Coordination, and Common Knowledge.* Princeton, NJ: Princeton University Press.

Crouch, Colin and Henry Farrell. 2004 "Breaking the Path of Institutional Development? Alternatives to a New Determinism." *Rationality and Society* 16(1): 5-43.

Culpepper, Pepper. 2008. "The Politics of Common Knowledge: Ideas and Institutional Change in Wage Bargaining." *International Organization*, 62(1), 1-33

David, Paul. 1985. "Clio and the Economics of QWERTY." *American Economic Review, Papers and Proceedings of the Ninety-Seventh Annual Meeting of the American Economic Association.* 75(2) 332–37.

Davis, Gerald F. 2016. *The Vanishing American Corporation: Navigating the Hazards of a New Economy.* Berrett-Koehler Publishers, San Francisco, CA.

DiMaggio Paul. 1997. "Culture and Cognition." *Annual Review of Sociology* 23(1):263–87.

Dolan, Paul and Galizzi, Matteo Maria. 2015. "Like ripples on a pond: Behavioral spillovers and their implications for research and policy." *Journal of Economic Psychology.* 78. 10.1016.

Easterly, William and William Russell Easterly. 2006. *The White Man's Burden: Why the West's Efforts to Aid the Rest Have Done So Much Ill and So Little Good.* New York: Penguin.

Easterly, W. (2017). *The white man's burden: why the west's efforts to aid the rest have done so much ill and so little good.* Old Saybrook, CT: Tantor Media

The Economist 2021. "Fly me to the Moon Mariana Mazzucato wants to revive the Apollo spirit." January, 16.

Ergin, Haluk, Tayfun Sonmez and Utku Unver. 2017. "Dual-Donor Organ Exchange" *Econometrica* 85(5):1645-1671

Flores, Thomas, and Irfan Nooruddin. 2016. *Elections in Hard Times: Build- ing Stronger Democracies in the 21st Century.* Cambridge: Cambridge University Press.

Gabaix, Xavier. 2019. "Behavioral Inattention." in *Handbook of Behavioral Economics Volume 2.* Douglas Bernheim, Stefanot DellaVigna, and David Laibson (eds). Elsevier, London, UK.

Gaganis, Chrysovalantis, Iftekhar Hasan, Panagiota Papadimitri, and Menelaos Tasiou, (2019), " National Culture and Risk-Taking: Evidence from the Insurance Industry." *Journal of Business Research* 97: 104-116.

Gelfand, Michele et al. 2011. "Differences Between Tight and Loose Cultures:'A 33-Nation Study." *Science* 332:1100-1104

Gelfand, Michelle,Joshua Jackson, Xinyue Pan, et al. 201. "The Relationship Between Cultural Tightness–Looseness and COVID-19 Cases and Deaths: a Global Analysis." *Lancet Planet Health* DOI:https://doi.org/10.1016/S2542-5196(20)30301-6

Gilboa, Itzhak, and David Schmeidler, 1995. "Case-Based Decision Theory", *The Quarterly Journal of Economics*, Volume 110(3): 605–639

Gorodnichenko, Y., Roland, G. 2021. "Culture, Institutions and Democratization." *Public Choice* 187, 165–195.

Greif, Avner, and David D. Laitin. 2004."A Theory of Endogenous Institutional Change" *American Political Science Review* 98 (4): 633–52.

Guiso, Luigi, Paola Sapienza and Luigi Zingales. 2004. "The Role of Social Capital in Financial Development." *The American Economic Review.* 94:3, pp. 526 –56.

Guiso, Luigi, Paola Sapienza and Luigi Zingales. 2006. "Does Culture Affect Economic Outcomes?" *Journal of Economic Perspectives* 20 (2): 23–48

Guiso, L., Sapienza, P., Zingales, L. 2015. "The Value of Corporate Culture." *Journal of Financial Economics* 117(1): 60-76.

Guiso, L., Sapienza, P., Zingales, L. 2016. "Long-term persistence" *Journal of the European Economic Association* 14 (6), 1401-1436

Harstad, Ron, and Reinhard Selten. 2016. "Diminished-Dimensional Political Economy" *European Economic Review*, 83 (2016), 213-219

Hayek, Frederich. 1945. "The Use of Knowledge in Society" *The American Economic Review.* 35 (4): 519–530.

Henrich Joseph, Robert Boyd, Samuel Bowles, et al. 2001. "In search of homo economicus: Behavioral experiments in 15 small-scale societies." *The American Economic Review, Papers and Proceedings of the Hundred Thirteenth Annual Meeting of the American Economic* : 19(2):73–78.

Henrich, Joseph, Robert Boyd, Samuel Bowles, Herbert Gintis, Ernst Fehr, and Colin Camerer, eds. 2004. *Foundations of Human Sociality: Economic Experiments and Ethnographic Evidence in Fifteen Small-Scale Societies.* Oxford, UK: Oxford University Press.

Hidalgo, César, and Ricardo, Hausmann. 2009. "The building blocks of economic complexity", *Proceedings of the National Academy of Sciences* 106 (26) 10570-10575

Hofstede, Geert. (1980) *Culture's Consequences: International Differences in Work Related Values,* Sage, London.

Hurwicz, Leonid and Stanley Reiter. 2006. *Designing Economic Mechanisms.* Cambridge University Press. Cambridge, UK.

Inglehart, Ronald. 1997. *Modernization and Postmodernization: Cultural, Economic, and Political Change in 43 Societies.* Princeton, NJ: Princeton University Press.

Jackson, Matthew O., Brian W. Rogers, and Yves Zenou. 2017. "The Economic Consequences of Social-Network Structure." *Journal of Economic Literature*, 55 (1): 49-95.

Jehiel, Phillippe. 2005. "Analogy-based Expectation Equilibrium." *Journal of Economic Theory.* 123(2): 81-104.

Kranton, Rachel E. 1996. "Reciprocal Exchange: A Self-Sustaining System," *American Economic Review,*86(4):830–851.

Jung, Danielle, and Lake David A (2011) "Markets, hierarchies, and networks: an agent-based organizational ecology." *American Journal of Political Science* 55(4): 972–990.

Levitsky, Steven; Ziblatt, Daniel 2018. *How Democracies Die.* New York: Crown.

Lipset, Seymour Martin. 1959. "Some Social Requisites of Democracy: Economic Development and Political Legitimacy." *American Political Science Review* 53(1):69–105.

Lipton, David and Jeffrey Sachs. 1990. "Creating a Market Economy in Eastern Europe: The Case of Poland." *Brookings Papers on Economic Activity* 1990(1):75–133.

McFadden, Daniel (1974), "Conditional Logit Analysis of Qualitative Choice Behavior," in *Frontiers in Econometrics*, P. Zarembka, ed. New York: Academic Press, 105–42.

Malone, Thomas. 2018. *Superminds: The Surprising Power of People and Computers Thinking Together.* New York, NY. Little Brown & Company.

March, James G. and , Johan P. Olsen. 2004. "The logic of appropriateness." *In The Oxford handbook of political science.* Oxford University Press.

Maskin, Eric S. 2008. "Mechanism Design: How to Implement Social Goals." (Nobel Memorial Lecture) *The American Economic Review* 567–576.

Mazzucato, Mariana, *Mission Economy: A Moonshot Guide to Changing Capitalism* Harper Business. New York, NY.

Meadows, Donatella, 2008. *Thinking in Systems: A Primer*, Chelsea Green Publishing, Chelsea, Vermont.

Michalopoulos, Stelios, and Elias Papaioannou. 2014. "National Institutions and Subnational Development in Africa." *Quarterly Journal of Economics* 129 (1): 151–213.

Morag-Levine, Noga. 2009. *Chasing the Wind: Regulating Air Pollution in the Common Law State.* Princeton University Press. Princeton, NJ.

Mourouzidou-Damtsa, Stella, Andreas, Milidonis, Konstantinos Stathopoulos. 2019 "National Culture and Bank Risk-Taking." *Journal of Financial Stability.* 40: 132-143

Myerson, Roger. 2008. "Revelation Principle." *The New Palgrave Dictionary of Economics.* Basingstoke: Palgrave Macmillan.

North, Douglass, 2005. *Understanding the Process of Economic Change.* Princeton: Princeton University Press.

Ostrom, Elinor. 2009. *Understanding Institutional Diversity.* Princeton, NJ: Princeton University Press.

Ostrom, Elinor. 1990. *Governing the Commons: The Evolution of Institutions for Collective Action.*Cambridge University Press. New York.

Page, Scott E. 2006. "Essay: Path Dependence." *Quarterly Journal of Political Science.* 1: 87–115.

Page, Scott E. 2012. "A Complexity Perspective on Institutional Design." *Politics, Philosophy and Economics* 11: 5-25.

Pierson, Paul. 2004. *Politics in time: history, institutions, and social analysis.* Princeton: Princeton University Press.

Putnam, Robert. 1993. *Making Democracy Work: Civic Traditions in Modern Italy.* With Robert Leonardi and Raffaella Y. Nanetti. Princeton, NJ: Princeton University Press.

Sah, Raaj Kumar and Joseph E. Stiglitz. 1988. "Committees, Hierarchies and Polyarchies." *The Economic Journal* 98(391): 451-470.

Simon, Herbert .A., 1997. *Models of bounded rationality: Empirically grounded economic reason* (Vol. 3). MIT press.

Swidler, Ann. 1986. "Culture in Action: Symbols and Strategies." *American Sociological Review* 51(2): 273-286.

Tabellini, Guido. 2008. "The Scope of Cooperation: Values and Incentives" *Quarterly Journal of Economics* 123 (3): 905–50.

Varshney, Ashutosh. 2002. *Ethnic Conflict and Civic Life: Hindus and Muslims in India.* Yale University Press, New Haven, CT.

4 Proofs

Proof of Claim 1: All realized values lie in the interval $[0, c_d]$. A market can be selected only if both democracies and hierarchies have realized values in the interval $[0, c_m]$. These occur with probabilities c_m/c_h and c_m/c_d respectively. Conditional on those holding, each institution is chosen with equal probability. Therefore, the probability of selecting a market equals $\frac{1}{3}$ times the product of c_m/c_h and c_m/c_d. This also equals the probability of choosing a hierarchy or democracy in the interval $[0, c_m]$. A hierarchy with value in the interval $(c_m, c_h]$ can be chosen provided the realized value of the democracy is not in the interval $[c_h, c_d]$. If the democracy has a realized value in the interval $[0, c_m]$, the hierarchy is chosen for sure. If the democracy has a realized value in the interval $(c_m, c_h]$, the hierarchy is chosen with probability one-half. Straightforward calculations give the result.

Proof of Corollary 1: All institutional types yield realized values in the interval $[0, c_m]$. We can partition this interval into three intervals $[0, c_d]$, $[c_d, c_h]$, and $[c_h, c_m]$. If the realized value lies in the first of these intervals, then all three institutions must have produced realized values in this interval. This occurs with probability $\frac{c_d^2}{c_h c_m}$. The proof is as follows. Democracies always produce realized values in this interval. Hierarchies and markets do with probabilities $\frac{c_d}{c_h}$ and $\frac{c_d}{c_m}$ respectively. Given the assumption of a uniform distribution on potential outcome values, it follows that the expected value of the best of the three realized values in this interval will equal $\frac{3c_d}{4}$. Therefore, the contribution to expected realized value from the first interval equals

$$\frac{3c_d^3}{4c_h c_m}$$

The realized value comes from the interval $[c_d, c_h]$ if both the market and the hierarchy produces realized values in this interval or if one produces a realized value in this interval and the other produces a realized value in the interval $[0, c_d]$. The first of these events has probability $\frac{(c_h - c_d)^2}{c_h c_m}$ and produces an expected payoff of $\frac{2(c_d + c_h)}{3}$. The probability that the market produces a realized value in the first interval and the hierarchy produces a realized value in the second interval equals $\frac{c_d}{c_m} \cdot \frac{(c_h - c_d)}{c_h}$. If this event occurs, only one draw from the second interval occurs, so the expected value of that draw equals $\frac{(c_d + c_h)}{2}$. Using the same argument, the probability that the hierarchy produces a value in the first interval and the market produces a realized value in the second interval equals $\frac{(c_h - c_d)}{c_m} \cdot \frac{c_d}{c_h}$. This also has expected value $\frac{(c_d + c_h)}{2}$. Therefore, the contribution to expected realized value from the second interval equals

$$\frac{(c_h - c_d)^2}{c_h c_m}\frac{2(c_d + c_h)}{3} + \frac{(c_h - c_d)}{c_m}\frac{c_d}{c_h}\frac{(c_d + c_h)}{2} + \frac{(c_h - c_d)}{c_m}\frac{c_d}{c_h}\frac{(c_d + c_h)}{2}$$

Which simplifies to

$$\frac{2(c_h - c_d)(c_h^2 - c_d^2)}{3c_h c_m} + \frac{(c_h^2 - c_d^2)}{c_m c_h}$$

Finally, if the realized value comes from the interval $[c_h, c_m]$, then it must come from a market. This occurs with probability $\frac{(c_m - c_h)}{c_m}$ and has an expected realized value of $\frac{c_h + c_m}{2}$ implying a contribution to expected realized value equal to the following:

$$\frac{(c_m^2 - c_h^2)}{2c_m}$$

Summing the contributions from the three intervals gives the following expression:

$$\frac{9c_d^3 + (8c_h - 8c_d + 12)(c_h^2 - c_d^2) + 6c_h(c_m^2 - c_h^2)}{12c_h c_m}$$

Proof of Claim 2: The cultural capacity for institutions of type i equals λ_i times the level of capacity c_g. The result follows from Claim 1.

Proof of Corollary 3:. The performance of institutional type i equals c_g times the product of θ_i and λ_i. Therefore, we can factor out c_g. The result follows from corollary 1.

Proof of Claim 3:

Proof of part (i): To prove stability for the equal representation ensemble, we first consider the case in which a single type of institution has increased in proportion . Without loss of generality, assume that democracies has increased to $\left(\frac{1}{3} + 2\epsilon\right)$, which implies that the proportion of markets and hierarchies have each reduced to $\left(\frac{1}{3} - \epsilon\right)$. From claim 1, the proportion of markets equals

$$m = \frac{G(\frac{1}{3} - \epsilon)^2}{3G(\frac{1}{3} - \epsilon)G(\frac{1}{3} + 2\epsilon)}$$

This simplifies to

$$m = \frac{G(\frac{1}{3} - \epsilon)}{3G(\frac{1}{3} + 2\epsilon)}$$

Using Taylor series expansion, it suffices to show:

$$\frac{G(\frac{1}{3}) - \epsilon G'(\frac{1}{3})}{3G(\frac{1}{3}) + 6\epsilon G'(\frac{1}{3})} > \left(\frac{1}{3} - \epsilon\right)$$

Multiplying through and ignoring higher order terms gives:

$$G(\frac{1}{3}) - \epsilon G'(\frac{1}{3}) > G(\frac{1}{3}) + 2\epsilon G'(\frac{1}{3}) - 3\epsilon G(\frac{1}{3})$$

Cancelling and rearranging terms gives $G(\frac{1}{3}) > G'(\frac{1}{3})$. Alternatively, suppose that the proportion of markets decreases by 2ϵ and the proportion of democracies and hierarchies increases by ϵ. It then suffices to show

$$\frac{G^2(\frac{1}{3} - 2\epsilon)}{3G^2(\frac{1}{3} + \epsilon)} > (1 - 2\epsilon)$$

Using Taylor series expansion, it suffices to show:

$$\frac{G^2(\frac{1}{3}) - 4\epsilon G(\frac{1}{3})G'(\frac{1}{3})}{3G^2(\frac{1}{3}) + 6\epsilon G(\frac{1}{3})G'(\frac{1}{3})} > \left(\frac{1}{3} - 2\epsilon\right)$$

This simplifies to:

$$\frac{G(\frac{1}{3}) - 4\epsilon G'(\frac{1}{3})}{3G(\frac{1}{3}) + 6\epsilon G'(\frac{1}{3})} > \left(\frac{1}{3} - 2\epsilon\right)$$

Multiplying through and ignoring higher order terms gives:

$$G(\frac{1}{3}) - 4\epsilon G'(\frac{1}{3}) > G(\frac{1}{3}) + 2\epsilon G'(\frac{1}{3}) - 6\epsilon G(\frac{1}{3})$$

Cancelling and rearranging terms also gives $G(\frac{1}{3}) > G'(\frac{1}{3})$.

Proof of part (ii): To prove stability for the homogeneous ensemble, we assume a perturbation from the ensemble consisting of entirely markets, $(0, 0, 1)$, to the ensemble with a proportion ϵ of hierarchies $(0, \epsilon, 1 - \epsilon)$. To prove stability, it suffices to show the proportion of hierarchies decreases:

$$\frac{G(\epsilon)}{2G(1 - \epsilon)} < \epsilon$$

Using Taylor series expansion and the fact that $\hat{G}(0) = 0$, it suffices to show:

$$\frac{\epsilon G'(0)}{G(1) + 2\epsilon G'(1)} < \epsilon$$

Rearranging terms and ignoring higher order terms yields $G'(0) < 2G(1)$.

Proof of Claim 4:

(i) The equal representation ensemble is an equilibria by claim 1. From claim 3, let $G(i) = i^\beta$.. The necessary and sufficient condition can then be written as $\beta(\frac{1}{3})^{\beta-1} < (\frac{1}{3})^\beta$. Multiplying both sides by $(\frac{1}{3})^{1-\beta}$ gives $\beta < \frac{1}{3}$.

(ii) To derive the general form of the institution predominant equilibrium ensembles, we consider the democracy predominant ensemble (m_d, h_d, d_d), where $m_d = h_d < d_d$. It follows that

$$(m_d, h_d, d_d) = \left(\frac{m_d^\beta}{3d_d^\beta}, \frac{h_d^\beta}{3d_d^\beta}, 1 - \frac{m_d^\beta}{3d_d^\beta} - \frac{h_d^\beta}{3d_d^\beta}, \right)$$

Solving for m_d gives $m_d^{1-\beta} = \frac{1}{3d_d^\beta}$, which implies

$$m_d^\beta = \left(\frac{1}{3}\right)^{\frac{\beta}{1-\beta}} \left(\frac{1}{d_d}\right)^{\frac{\beta^2}{1-\beta}}$$

Substituting this into the expression for d_d gives

$$d_d = 1 - \frac{2}{3}\left(\frac{1}{3}\right)^{\frac{\beta}{1-\beta}} \left(\frac{1}{d_d}\right)^{\frac{\beta^2}{1-\beta}} \left(\frac{1}{d_d}\right)^{\beta}$$

rearranging terms gives

$$\frac{2}{3}\left(\frac{1}{3}\right)^{\frac{\beta}{1-\beta}} \;=\; (1 - d_d) d_d^{\frac{\beta}{1-\beta}}$$

raising both sides to the power $(1 - \beta)$ gives

$$2^{1-\beta} \;=\; 3(1 - d_d)^{1-\beta} d_d^\beta$$

For $\beta \in (\frac{1}{3}, 1)$, the left hand side of the equation strictly decreases in β and takes values in the interval $(2^{\frac{2}{3}}, 1)$. The right hand side is maximized at $d_d = \beta$, where it takes the value $3\beta^\beta(1-\beta)^{(1-\beta)}$. It follows that there will be some level of increase in d_d where an equilibrium is reached.

Proof of Corollary 4: We first derive first order necessary conditions for the democracy dominant ensemble (m_d, h_d, d_d) to maximize expected payoff. From corollary 1, we can write the expected performance in the general case as follows:

$$\frac{9c_m^3 \ + \ (8c_h - 8c_d + 12)(c_h^2 - c_m^2)}{12c_h c_d} \ + \frac{(c_d^2 - c_h^2)}{2c_d}$$

Given that $c_m = c_h$, the expected realized value equals $\frac{c_m^2}{4c_d} \ + \frac{c_d}{2}$. We ca thus write the expected performance as

$$\frac{m_d^{2\beta}}{4d_d^{\beta}} + \frac{d_d^{\beta}}{2}$$

Setting $m_d = \frac{(1-d_d)}{2}$ gives the following expression:

$$\frac{(1-d_d)^{2\beta}}{2^{(2+2\beta)}d_d^{\beta}} + \frac{d_d^{\beta}}{2}$$

If suffices to maximize the following expression:

$$\frac{(1-d_d)^{2\beta}}{d_d^{\beta}} + 2^{(2\beta+1)}d_d^{\beta}$$

Taking the partial derivative with respect to d_d gives the first order necessary condition:

$$\frac{-2d_d^{\beta}\beta(1-d_d)^{2\beta-1} + \beta d_d^{\beta-1}(1-d_d)^{2\beta}}{d_d^{2\beta}} + 2^{(2\beta+1)}\beta d_d^{\beta-1} = 0$$

Dividing by β and simplifying gives:

$$\frac{-2d_d(1-d_d)^{2\beta-1} + (1-d_d)^{2\beta}}{d_d^{\beta+1}} + 2^{(2\beta+1)}d_d^{\beta-1} = 0$$

Which reduces to the following::

$$\left(\frac{2d_d}{1-d_d}\right)^{2\beta-1} - \frac{(1+d_d)}{4d_d} = 0$$

Given that $d_d > \frac{1}{3}$, the term inside the first parenthesis strictly exceeds one and the term inside the second parentheses is strictly less than one. Therefore, if $\beta \geq \frac{1}{2}$, the right hand side is strictly greater than zero, which implies that performance increases in d. This implies that the homogeneous ensemble

maximizes expected payoff.

For $\beta < \frac{1}{2}$, we first multiply both terms in the first order necessary condition by $4d_d$ to obtain:

$$2^{2\beta+1} d_d^{2\beta} \left(\frac{1}{1-d_d}\right)^{2\beta-1} - (1+d_d) = 0$$

Recall that d_d satisfies the following expression:

$$d_d^{\beta} = \frac{1}{3}\left(\frac{2}{1-d_d}\right)^{1-\beta}$$

Which implies that

$$d_d^{2\beta} = \frac{1}{9}\left(\frac{2}{1-d_d}\right)^{2-2\beta}$$

Substituting this back into the first order necessary condition gives the following:

$$\frac{8}{9}\left(\frac{1}{1-d_d}\right) - (1+d_d) = 0$$

This implies $\frac{8}{9} = (1-d_d^2)$ and that $d_d = \frac{1}{3}$, which proves that no interior institutional dominant equilibrium can be payoff maximizing. Last, we consider the equal representation ensemble $(m, h, d,) = (\frac{1}{3}, \frac{1}{3}, \frac{1}{3})$. equilibrium ensemble must be the equal representation ensemble. We have just shown that this satisfies the first order necessary condition. However, to prove that this is a maximum, second order sufficient condition must hold:

$$2^{2\beta+1}(2\beta) d^{2\beta-1}\left(\frac{1}{1-d}\right)^{2\beta-1} - 2^{4\beta} d^{2\beta}\left(\frac{1}{1-d}\right)^{2\beta-1} - 1 < 0$$

Rearranging terms gives:

$$2^{2\beta+1}\left(\frac{d}{1-d}\right)^{2\beta-1}\left[2\beta + \frac{(2\beta+1)d}{1-d}\right] - 1 < 0$$

Evaluating at $d = \frac{1}{3}$ gives $(3\beta - \frac{1}{2}) < \frac{1}{4}$, which is equivalent to $\beta < \frac{1}{4}$ which completes the proof.

Proof of Claim 5: Denote he market dominant equilibrium ensemble by $(m_\Delta, h_\Delta, d_\Delta)$, with $m_\Delta > \frac{1}{3}$. It follows that

$$(m_\Delta, h_\Delta, d_\Delta) \;=\; \left(1 - \frac{2}{3}\frac{d_\Delta^\beta}{[(1+\Delta)m_\Delta]^\beta}, \frac{d_\Delta^\beta}{3[(1+\Delta)m_\Delta]^\beta}, \frac{d_\Delta^\beta}{3[(1+\Delta)m_\Delta]^\beta}\right)$$

Solving for d_Δ gives:

$$d_\Delta^{1-\beta} = \frac{1}{[3(1+\Delta)m_\Delta]^\beta}$$

Which implies

$$d_\Delta^\beta = \left(\frac{1}{3}\right)^{\frac{\beta}{1-\beta}} \left(\frac{1}{(1+\Delta)m_\Delta}\right)^{\frac{\beta^2}{1-\beta}}$$

Substituting this into the expression for m_Δ gives

$$m_\Delta = 1 - \frac{2}{3}\left(\frac{1}{3}\right)^{\frac{\beta}{1-\beta}} \left(\frac{1}{(1+\Delta)m_\Delta}\right)^{\frac{\beta^2}{1-\beta}} \left(\frac{1}{(1+\Delta)m_\Delta}\right)^{\beta}$$

rearranging terms gives

$$\frac{2}{3}\left(\frac{1}{3}\right)^{\frac{\beta}{1-\beta}} \;=\; (1-m_\Delta)\left((1+\Delta)m_\Delta\right)^{\frac{\beta}{1-\beta}}$$

raising both sides to the power $(1-\beta)$and rearranging terms gives the equilibrium equation:

$$\frac{2^{1-\beta}}{3(1+\Delta)^\beta} \;=\; 3(1-m_\Delta)^{1-\beta} m_\Delta^\beta$$

Implicit differentiation shows that m_Δ increases in Δ and that the rate of increase decreases in β.

Proof of Claim 6:. We first derive the threshold on λ for there to exist an equilibrium of the form $(\frac{1-d^*}{2}, \frac{1-d^*}{2}, d^*)$ with $d^* > \frac{1}{3}$. At such an equilibrium, the following equations must hold:

$$m^* \;=\; h^* = \frac{1}{3}\frac{\frac{1-d^*}{2} + \lambda d^*}{d^*} \qquad d^* \;=\; 1 \;-\; \frac{2}{3}\frac{\frac{1-d^*}{2} + \lambda d^*}{d^*}$$

Setting $m^* = \frac{1-d^*}{2}$ and multiplying both sides of the first equation by $6d^*$ gives $3(d^* - d^{*2}) = 1 - d^* + 2\lambda d^*$ which can be rewritten as $0 = 3d^{*2} - (4-2\lambda)d^* + 1$. This equation has real roots if and only if $4\lambda^2 - 16\lambda + 4 \geq 0$, which implies that $\lambda \leq (2-\sqrt{3})$. The equilibrium proportion of democracies equals $d^* = \frac{4-2\lambda-2\sqrt{\lambda^2-4\lambda+1}}{6}$. At the threshold value for λ, the proportion of democracies equals $\frac{\sqrt{3}}{2}$, implying a discontinuous shift in the equilibrium set.

To prove that there cannot exist an equilibrium of the form $(\frac{1-d^*}{2}, \frac{1-d^*}{2}, d^*)$ with $d^* < \frac{1}{3}$, note that at such an equilibrium, the following equations must hold:

$$d^* = \frac{1}{3}\frac{d^*}{m^* + \lambda d^*} \qquad m^* = h^* = \frac{1}{2} - \frac{1}{6}\frac{d^*}{m^* + \lambda d^*}$$

The first equation can be rewritten as $(3m^* + 3\lambda d^*) = 1$, which if $m > \frac{1}{3}$ implies $d^* = 0$. It follows from the proof of corollary 3, that the equilibrium $(\frac{1}{2}, \frac{1}{2}, 0)$ is unstable. Finally, any equilibrium of the form (m^*, h^*, d^*) with $m^* > h^* \geq d^*$ must satisfy

$$d^* = \frac{1}{3}\frac{d^*}{m^* + \lambda d^*} \qquad h^* = \frac{1}{2}\frac{h^* + \lambda d^*}{m^* + \lambda d^*} - \frac{1}{6}\frac{d^*}{m^* + \lambda d^*} \qquad m^* = 1 - d^* - h^*$$

which from above has $d^* = 0$. It follows that $h^* = \frac{h^*}{2m^*}$, which given $h^* < m^*$, implies a unique solution at $(1, 0, 0)$.

Proof of Claim 7: We consider an ensemble equilibrium of the form $(m, 0, d, s, 0)$ with $m = s < d$. This implies that $c_m = m + \lambda(1 - 2m)$ and $c_d = 1 - 2m + \lambda m$. In equilibrium:

$$m = \frac{1}{3}\frac{m + \lambda(1 - 2m)}{1 - 2m + \lambda m}$$

Rearranging terms gives $(6 - 3\lambda)m^2 - 2(\lambda + 1)m + \lambda = 0$. This has real roots $\frac{3\lambda}{6-3\lambda}$ and $\frac{2}{3}$. Only the first root is feasible. It follows that the ensemble equilibrium has the form $(\frac{3\lambda}{6-3\lambda}, 0, \frac{6-9\lambda}{6-3\lambda}, \frac{3\lambda}{6-3\lambda}, 0)$