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Complexity Economics and Workaday Economic Policy

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Abstract

Much of what filters down to standard economists about complexity economics are summaries of abstract analysis that are generally seen as having little direct impact on the workaday policy analysis that most economists do. This chapter argues that complexity theory has significant implications for workaday economic policy. Even if economists do not accept that the complexity *scientific theory* of the economy is ready for prime time, the complexity vision, which pictures an economy as a complex evolving system undergoing continual evolutionary change, has direct relevance for their workaday applied policy. The reason is that good applied policy is not applied science but rather more like engineering. This chapter explains why applied policy should not be viewed as applied science and explores some implications and examples of how using a complexity frame for economic policy changes workaday applied economic policy analysis.

Specifically, it is argued that complexity policy opens up economics to a wide range of policies that go beyond the standard allocation policies that economists tend to focus on in the standard policy approach, and supplements them with a set of policies designed to influence the ecostructure within which individuals operate. This adds what might be called formation policy to allocation policy. Formation policy does not see the market and government as opposites, but rather views them as coevolving institutions. Formation policy is designed to influence that coevolution. An example of how complexity policy differs from standard policy can be seen in distribution policy. The standard approach to distribution policy tends to focus on redistributive taxes such as progressive income and wealth taxes. The complexity policy approach to distribution focuses more on modifying the length and nature of evolving property rights as embedded in patent and copyright law.

Introduction

For those of us working in complexity economics, it is an exciting time, and we sometimes wonder why all economists are unable to see complexity's potential

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and usefulness. Why doesn't everyone join us and jump on the complexity bandwagon? One reason is that much of what filters down to standard economists from complexity economics are summaries of abstract analysis—critiques of Walrasian general equilibrium theory, discussions of butterfly effects, sensitive dependence on initial conditions, and stories of "living economies in a computer"—narratives which, while interesting, are generally seen as having little direct impact on the workaday policy analysis that most economists do.

The reality is that workaday economics is done with little reference to abstract theory, new analytic techniques, or advanced computational technology. You don't teach general equilibrium to beginning or even intermediate students; you're lucky if they follow supply and demand. You don't base your policy analysis on general equilibrium theory; you develop a simple model, collect data, process that data, and come to a conclusion. Abstract theory, whether complex or not, has little direct relevance to workaday economics.

Despite its lack of direct relevance, most economists are interested in complexity economics. But they are interested in it as a consumption good—a throwback to the abstract thinking done in graduate school during late night bull sessions when they asked the big questions—not as a production good that affects their applied policy research. The general sense of standard economists is that when it comes to their applied policy analysis, complexity economics has little to add, other than that the economy is complex, something they already knew.

My goal in this chapter is to challenge that view, and to explain why complexity has enormous implications for how workaday applied policy economics is done.[1] The argument can be summarized as follows: Complexity economics involves both a *complexity scientific theory* of the economy and a *complexity vision* of the economy. Most economists are willing to accept that the vision of the economy as a complex evolving system undergoing continual evolutionary change is interesting; it resonates with their intuition. But economists are generally far less likely to accept that a complexity scientific theory of the economy is ready for prime time. For them, complexity economics has not cleared the scientific bar. Because standard economists see good applied policy as applied science, it follows that, for them, complexity economics has little relevance for their workaday applied policy.

Here I argue that that view of "applied policy as applied science" is wrong. The centrally important creative and design part of applied policy is not dependent on the reigning scientific paradigm because it is not applied science. If done in a reasonable way, it has little concern with what the scientific paradigm is.

This "applied policy is not applied science" approach is well understood, and followed, in the engineering profession. It is not understood, or followed, in economics. A change in that view would have significant implications for

[1] It also has significant implications for how economics is taught, but that involves a different set of issues than those I will discuss here.

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workaday economics, making workaday applied policy analysis much more open to complexity and evolutionary policy insights. It would mean that economic policy work would not be limited by what we scientifically know; it would be based on any information or idea that might be useful in fashioning a solution to the policy problem under consideration. So even if one holds that complexity science is still in the formative stages, and that complexity analytic tools and models are not ready for prime time, complexity economics can still have important implications for how workaday applied economic policy is done.

First, I address complexity science and vision, and their relation to economists' current policy frame. Second, I discuss why applied policy should not be seen as applied science, but rather as engineering, and how adopting an engineering methodology makes the complexity vision important for workaday policy analysis. Finally, I explore some implications and examples of how using a complexity frame for economic policy changes workaday applied economic policy analysis.

Complexity Science and Complexity Vision

Policy is often thought of as applied science. What is meant by a scientific theory is generally ambiguous and much in debate; however, in economics, economic science is usually interpreted as work that has developed out of existing Walrasian general equilibrium theory. Complexity science challenges that Walrasian general equilibrium (WGE) theory as the core scientific theory. As Wilson et al. stated in their overview paper for this Forum, complexity economics challenges (a) the equilibrium focus of the WGE theory (namely, complexity economics would model economic systems as "complexly adaptive and frequently out of equilibrium," not as a system in equilibrium), and (b) the unrealistic treatment of preferences and rationality in WGE theory (complexity theory views preferences and tastes as endogenous, and rationality as being far more complicated than WGE theory does). They argue that making these changes involves a paradigmatic shift in economics.

The problem for complexity economics supporters is that the large majority of economists are not ready for a paradigmatic shift in economics, not because they love general equilibrium theory but because they have learned to live with it. General equilibrium theory serves as a background policy frame, providing the theoretical basis for cost-benefit analysis, guidance for whether and how to internalize externalities as well as how to conduct tax and subsidization policy.[2] In fact, it indirectly underlies almost all of economists' thinking about

[2] Policy following from behavioral economics, such as nudges, is the exception. Because it is an exception, it has been slow to be accepted by standard economists as anything other than a tangential addendum to standard economic policy.

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policy. It has been extraordinarily useful in structuring thinking about policy; it has met a usefulness criterion.

Despite its indirect importance, WGE theory has little direct relevance to workaday economic policy. The standard economist's actual workaday applied policy economics makes almost no direct reference to WGE theory, social welfare functions, or welfare theorems. That theory is too abstract to use directly when thinking about policy. For most economists, WGE theory is something they learned in graduate school and has since receded to the deep recesses of their minds. While it lurks in the background, it is not what they are thinking of when they do applied policy. Because WGE theory is not seen as directly relevant for applied policy analysis, complexity economists' challenge to WGE theory is seen as having little relevance to them. They do applied policy analysis, and the musings of economic theoreticians worried about abstract complexity issues is seen as having little direct impact on what they do.

For most standard economists, even those sympathetic to complexity ideas, complexity economics does not yet meet the standards of scientific understanding. It involves conjectures and speculation about the economy that, while interesting, are scientifically unproven and thus remain in the speculative branch of economics. For most standard economists, complexity economics is not yet ready to replace WGE theory, which, while limited and hobbled by untenable assumptions, is at least logically correct, and has been demonstrably useful in providing a guide for policy.

I am not a scientific methodologist and am not qualified to render a meaningful opinion on whether using WGE theory as economists' core scientific model is appropriate or not. My leanings are that it is not, but I accept, by design, that formal scientific general theories embody unrealistic assumptions. Scientific theories are developed to provide abstract understanding, not policy guidance; unrealistic assumptions are the cost of the clarity needed for truth. Thus, I can accept that keeping WGE as the scientific theory might follow from scientific methodology, which places an enormous burden of proof on a new theory. Paradigmatic changes in science do not, and should not, come lightly; scientific methodology is designed to counter people's proclivity to be fast pattern completers—and see things that are not there. Scientific methodology involves what I call a set of slow pattern completing rules. That conservative methodology is designed to ensure that science is based on the most likely true knowledge.

The above issues are debatable, but for purposes of this article, I will accept that the arguments for keeping WGE as economists' scientific theory are tenable. For most economists, that is the end of the story. For them, complexity is not ready to become the new paradigm in economics: it has few implications for applied policy since applied policy is applied science. This is the step that I want to challenge here. I argue that applied policy should not be seen as applied science, and that even though much applied policy is done with little thought of formal scientific methodology and general equilibrium theory, both

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limit indirectly what economists do in their applied policy. If applied policy is more explicitly seen as engineering, the debate about what economists' scientific theory is becomes almost irrelevant to how applied policy analysis is conducted. That allows complexity to influence economists' policy analysis in ways that it currently does not.

Applied Economics Is Not Applied Science

If applied economics should not follow a scientific methodology, what methodology should it follow? My answer is that applied economics should follow *an engineering methodology* (this idea is further developed in Colander 2015). Engineers do not see engineering as applied science. Engineers use science and, where appropriate, use scientific methodology. However, engineers differ from scientists in that they allow and encourage analysis to be based on intuition, guesses, gut feelings, and a whole variety of elements which they do not claim meet scientific muster. The reason why is that good engineering is a creative endeavor. It is not a formal scientific endeavor. Its goal is to solve problems—to discover solutions that work in the real world, not to find capital T (or even small t) truth. If a solution that works in the real world does not work in the existing scientific theory, so be it.

Billy Vaughn Koen (2003) defines the engineering method as "the strategy for causing the best change in a poorly understood or uncertain situation within the available resources." Alternatively, he defines it as the use of the best available engineering heuristics to solve problems. Those definitions serve as useful statements of the method appropriate for workaday applied economic policy. Koen emphasizes that since no part of knowledge is infallible, appropriate heuristics include all theories, models, and any other aid (e.g., intuition, experience, expert knowledge) that may usefully lead to a solution. In this engineering method, nothing is off the table. By explicitly calling the models and other aids that an engineer uses to arrive at a conclusion *heuristics*, Koen calls attention to any model's problems and encourages a methodological approach that is open to all evidence and arguments. Engineering, and hence applied policy, has a different threshold of importance than science. Science searches for truth; whereas engineering, if applied to economic problems, searches for answers to policy questions.

Translated into economics, this means that WGE theory is simply one of many heuristics that might be useful in tackling the wide range of policy issues that economics considers. Its usefulness in applied policy can only be ascertained by considering how its usefulness compares to the other heuristics, such as a complexity policy frame's usefulness for the particular problem at hand. An applied policy economist following an engineering methodology would be continually trying alternative heuristics to see which is most useful for a

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particular set of problems; this person would be far less tied to the standard WGE policy frame than standard economists are.[3]

Koen emphasizes that the appropriate heuristics will be constantly changing, and discussion of them will be part of what every engineer does. Thus, while abstract methodology is not much discussed by engineers, practical methodology is constantly discussed. It is integrated into what engineers do, so all engineers are simultaneously engineers and methodologists. Put another way, methodology is an important part of engineering, but it is a narrowly applied micro-methodology of best practices for particular areas, with a very loose general methodology that can probably best be described as an *educated common sense* methodology. Koen calls it a "universal method." The particular branch of engineering, and the particular problem the engineers are trying to solve, will determine how important the scientific heuristic is and how important other heuristics are. There is no one overriding engineering heuristic. Engineering heuristics make no attempt to be value free. Engineering recognizes that values are an integral part of policy analysis and, instead of trying to be value free, is concerned with making the values in the analysis clear, so outsiders can decide whether they agree with them or not.

Thinking of applied economic policy as engineering, not science, opens up new avenues of policy considerations that allow complexity insights to enter the policy discussion long before the science of complexity is ready for prime time. It encourages economic discourse about policy to include much more daydreaming, speculation, and playing around with ideas. Specifically, using an engineering methodology for applied policy, the assumptions that currently guide much of the policy analysis done by economists—exogenous tastes, no interdependent utility functions, no contagion, no evolutionary institutions, and extreme rationality—would not be limiting on policy analysis. They were only used because they led to tractable scientific models: all have their roots in WGE theory not in their usefulness for policy, but their usefulness in finding the truth.

Using an engineering methodology, the standard assumptions would no longer hold the power over applied policy that they currently do. The WGE heuristic would likely be replaced by a variety of heuristics that are more consistent with observed empirical reality for policy purposes, even as one kept WGE as one's scientific theory. Using the complexity vision to think about policy allows applied policy analysts to modify scientific assumptions for their policy heuristics, and to explore policy issues that are outside the standard ones economists examine. Eliminating these arbitrary assumptions would change

[3] Extreme care must be used in actually applying heuristic insights into policy, and ensuring that moral issues are integrated into the analysis, which is one of the reasons the welfare economics followed the path that it did: it wanted to avoid addressing issues of morality and value judgments. However, as Hume long ago noted, policy inherently involves morality and value judgments. To pretend they are not there is not a viable option.

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policy analysis enormously. It would open up a wide range of policies to exploration by economists using different models.

Let me be clear: my argument is not that the complexity vision would overthrow existing theory and applied policy. Where the existing models work better than the new models as a guide for policy, the existing models will continue to be used. But what works best—what is the best current state-of-the-art heuristic—can only be known by comparison of the usefulness of the various models. This comparison is not happening now.

Implications of the Complexity for Policy

If the engineering approach to applied policy were followed, the complexity frame for policy would be one of the alternative frames that would be explored. In Colander and Kupers (2014), I explored some of the ways in which thinking about policy would change using a complexity frame:

1. We don't understand the complex evolving economy, and probably can never understand it fully. Complex systems are not amenable to control, and we should give up the ambition to control the economic system.
2. While we cannot control the economy, we can influence it in a myriad of ways; the standard policy model rules out many of these avenues; influence comes about not just through incentives within the existing institutional structure. A key focus of policy within the complexity policy frame involves positively influencing the evolution of institutions. It involves issues of formation as well as allocation.
3. The economy and the government are coevolving complex systems that cannot be considered separately. There aren't separate market and government solutions to problems. Solutions can be more bottom-up or more top-down, but both require some type of either explicit or implicit government policy to bring them about, even if that policy is to do nothing. The market is not the opposite of the government; successful market economies are testimonies of the success of previous government policies.
4. The success of bottom-up policy depends on the ecostructure within which people operate and the normative codes that they follow. Thus ecostructure and norms policy are central to complexity policy.
5. There is no general complexity policy; complexity policy is contextual and consists of a set of tools, not a set of rules, to help the policy maker come to reasonable conclusions.
6. Government is an evolving institution and can evolve in different ways. Complexity policy includes policies that affect government, and the role of government will change with the problems and the current

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state of government. There can be no noncontextual general policy recommendations.

7. Complex systems often experience path dependencies, nonlinearities, and lock-ins. Methods need to be designed to determine when these have occurred, and policies reflecting these dynamics need to be designed to influence the economy's evolution.
8. Policies can be achieved with bottom-up or top-down methods of influence. Top-down policies should not be seen as a one-time policy, but as a policy process that evolves as institutions evolve. Bottom-up policies allow endogenous evolution as institutions involve.

How these issues relate to policy involves a multifaceted set of considerations that can only be touched on here. In the following discussion, I give a sense of how they can affect workaday applied policy economics.

Ecostructure and Activist Laissez-Faire Policy

A major difference between the complexity frame and the standard WGE control policy frame is that the complexity frame does not view the market and the government as polar opposites; it sees them as having coevolved and as highly interdependent. This means that complexity policy analysis cannot use a market solution as a reference point for policy analysis because the market would not exist without government. In the complexity policy frame, "efficiency" is not a general goal within the model; policy goals have to be specified by the policy analyst. Efficiency has meaning only in relation to those outside specified goals.

What in the WGE policy frame are seen as market failures are, in the complexity frame, seen as ecostructure failures: they involve a failure in the formation of institutions. Policies on how to address these failures effectively might entail either more or less direct government involvement. Complexity theory does not tell you which. Put another way, instead of a market versus government policy dichotomy, the complexity policy frame has a bottom-up versus top-down policy dichotomy, and the choice between them is based not on theory but rather on judgments, such as a judgment on how similar policies have worked elsewhere in similar circumstances. In the complexity policy frame there is no definitive theoretical argument for or against a policy; instead, a researcher uses history and context-specific model heuristics as guides.

Bottom-up policy is the complexity equivalent to laissez-faire policy. But bottom-up policy is quite different from laissez-faire as is often interpreted. Within the complexity frame, laissez-faire is a government policy of encouraging bottom-up solutions to problems; it is not an absence of government policy.[4] Bottom-up policy has government actively encouraging individuals to

[4] As discussed elsewhere (Colander 2009), sophisticated Classical economists saw policy in this way, and is what Lionel Robbins meant when he said that "laissez-faire is the state."

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solve their own problems, and providing an ecostructure that will help them do so. It tries to maintain fairness, but otherwise stays out of the way. Top-down policy is designed to solve the problem using existing government institutions. Bottom-up policy tends to be slower than top-down policy, but it also tends to be more robust since it utilizes individuals' local knowledge which is unavailable to government policy makers.

In the complexity frame, there is no necessary correlation between one's concern about social problems and one's view of the efficacy of top-down or bottom-up solutions. For example, one can be enormously socially concerned but still be a strong bottom-up policy supporter if one's assessment is that government top-down policies to address social problems have serious negative side effects. Elinor Ostrom provided guidance for thinking about bottom-up policy within the context of common pool resources. Her work and the sophisticated interpretations of Ronald Coase (Medema 2011) can be seen as early pioneering efforts within the complexity policy frame.

Developing the Ecostructure to Achieve Social Goals

One way to demonstrate how using a complexity frame changes workaday applied policy work is to discuss how it has changed my applied policy work. In my current research, I am part of a large group working on developing an ecostructure that will encourage bottom-up solutions to social problems. This research involves understanding the nature of what we call "for-benefit" enterprises, which are market-oriented enterprises run to achieve social goals, not private goals (Colander 2012). There is enormous interest and support for the development of these institutions, primarily from politicians, lawyers, and businesspeople. I am one of the few economists working on the project.

My interest came about from talking to some successful socially concerned entrepreneurs who had earned sufficient income to fulfill all their material needs and wants before they were 30, and who were thus turning to philanthropy. After exploring existing nonprofits, they became disillusioned with their effectiveness and were looking for a better way to achieve their social goals. This led them to explore whether they could set up private enterprises devoted to solving the social problem of their interest. Instead of just giving money, they wanted to "invest" and manage the enterprise whose bottom line would be their social goal. Interest in the topic led to a movement to create a fourth sector of the economy—one that would have many of the governance structures of private enterprises, but would have social, not private profit, goals. My contribution to the project has been in (a) exploring what standard economic theory has, and in the past has had, to say about profit maximization (they are different); (b) explaining economists' approach to integrating normative views into their analysis of the way the market works, and (c) exploring how the type of institution they would like to set up differs from other related institutions, such as L3Cs, B-corps, triple bottom-line companies, and social businesses.

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The project has me working with lawyers, businesspeople, and policy wonks on specific policy questions. The research has far less focus on general solutions than my previous standard applied policy research.[5] Even though the project does not focus on general solutions, it has led me to think about them and work on a paper that contrasts a "pure for-(social)-benefit enterprise" with its pure polar opposite—a "for-profit" enterprise of standard theory, with most real-world firms falling somewhere between the two extremes.

The project is very much applied policy work, but it is quite different from the applied policy work done in standard economics. It is suggestive of how applied policy work would change if economists adopt a complexity policy frame. It has been much more collaborative and transdisciplinary than my other research. It involves much more thinking outside the standard model and significant study of past economists' writing, as I try to come to grips with how economists' current policy heuristics evolved. The focus is on finding practical solutions to specific problems and issues. The research might lead to a "general solution" but the flow is from *specific to general* solution, not from *general to specific* solution as it is with most current "standard" economic work.

Policy Based on Replicator Dynamics

Having described how my research agenda changed when I switched to a complexity policy frame, I will discuss another way in which complexity will likely change workaday applied policy economics. Complexity economics gives researchers a new method of simplification along with new analytical and computational tools that free economists from relying on developing a specific analytically solvable model. Instead of building an equilibrium model, economists can develop and explore an evolutionary model within which research only has to specify the replicator dynamics, not the full equilibrium system.

Supplementing the standard policy frame with the complexity policy frame makes applied policy economists far less dependent on being able to specify the equations in the model, allowing them to base their policy analysis on more than the equilibrium properties of the model. In the complexity frame, instead of picturing the economy as a set of interdependent equations moving toward equilibrium, as is done in the standard policy frame, researchers can picture existing reality as the result of replicator dynamics that evolve over time. They can then create agent-based models to analyze those replicator dynamics and explore alternative policies designed to influence those replicator dynamics within these agent-based models.[6] Agent-based models allow researchers to

[5] In the month preceding this Forum, I attended two conferences related to this "for-benefit" topic: one in Washington sponsored by the Fed and the Urban Institute; another at Harvard sponsored by INET and Harvard. Both were highly interdisciplinary and involved issues normally considered outside the purview of economists.

[6] Important developmental work is being done in expanding and developing agent-based model-

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explore and base policy thinking on nonlinear dynamic models in which complex realities emerge and evolve. This means that tractable unique equilibrium models no longer need to be assumed; in fact, the very concept of equilibrium can be replaced by a new concept, basins of attraction, which opens up the formal study of equilibrium selection mechanisms. As these replicator dynamics complexity models are explored, new possibilities for policy will emerge.

The change is similar to one that is occurring in medicine, where standard medicine conceives of health policy as fighting germs, viruses, and bacteria. This approach is being currently supplemented by two alternative approaches. One is an evolutionary approach in which individuals are seen as ecosystems for billions of organisms which coevolve with individuals. Within this frame, a person's health is dependent on how that entire ecosystem works. The second is a genetic approach in which an individual's genetic code plays a central role in his or her health. In genetic medicine, a minute change in the genetic code can have enormous effects on the health of an individual. In both approaches, germs only capture part of the story. Just as the development of genetic and evolutionary theory have opened up entirely new branches of health policy, so too can the complexity frame open up entirely new branches of applied economic policy.

A Norms Policy

Once one thinks of the economic system in terms of its replicator dynamics, one is led naturally to a new type of economic policy for applied policy economists to explore: norms policy (a policy designed to achieve desired ends by influencing the tastes and norms of individuals). The reason one is led to norms policy is that in the complexity frame, norms are endogenous, so they naturally become part of the policy discussion (see, e.g., Fehr and Fischbacher 2004).

Accepting that norms are endogenous has significant implications for workaday applied policy analysis. For example, economists' current control policy frame directs researchers to think of policy in terms of government passing a law, a tax, or some other control measure to achieve the desired result. But that need not be the case. Once one uses a complexity model that has endogenous norms, mores, and culture-determining behavior, one is presented with a possible alternative for role government, not as a controller or law maker but as an influencer of norms. Roland Kupers and I argue that one of the most important roles for government is to provide a moral compass for society (Colander and Kupers 2014). If government fails to provide this, it will likely fail in everything. Once it has provided that moral compass, it can consider policies

ing relevant for policy. For example, George Mason University has developed a Computational Public Policy Laboratory under the direction of Rob Axtell, and Josh Epstein (2013) has recently expanded the nature of agents to include neurological foundations, allowing additional exploration of behavioral issues with agent-based models.

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designed to influence the norms in society positively. Behavioral economic "nudges" are beginning to explore this policy space, but the implications of endogenous norms and tastes go far beyond nudging.

Another example involves adding a new set of policy tools—influence tools—to its policy arsenal. Influence tools guide individuals toward "positive" norms. They might involve measures to legislate a new type of "government guidances"; that is, laws that are not enforced through power, but through social pressure—something like a fatwa in Islamic religion. These set of guidances might be called legislated mores; they are what people, through government, have decided are positive rules of behavior. Violating a more would not be punishable in the way a misdemeanor or a felony is; it would not lead to a fine or imprisonment. It might, however, lead to public disapproval and serve as a basis for deciding whether a person behaved appropriately in insurance and private tort claims.

Many of the gray areas of current policy, where individual rights seem to conflict with what society considers good practices, could be addressed using such government-specified mores. Examples where such mores, rather than laws, might be useful include activities such as wearing a seatbelt, using drugs, and certain sexual behaviors. Actions that are now criminalized could be decriminalized but simultaneously discouraged. How effective would such mores be? That is an empirical issue which applied policy economists would need to explore, using the broader complexity frame, in their analysis of how effective alternative methods are in discouraging behaviors which people (through government) have decided to inhibit.

An Alternative Complexity Policy Approach to Achieving a More Desirable Income Distribution

Let us now consider how an economist's policy approach to a specific problem—income distribution—might change if a complexity frame was adopted. Economists' current applied policy heuristic deals with income distribution as a *re*distribution problem. By that I mean that it takes marginal productivities as given and asks: How can one develop redistributive taxes that bring about a more desirable income distribution?

The complexity frames suggests an alternative approach. Rather than trying to *change the income distribution given marginal productivities*, one might consider policies that change tastes, norms, and institutionally determined marginal productivities using the complexity approach. Policy could be designed to structure the property rights and institutions so that the marginal productivities of individuals are more equal, thereby making the distribution of income more equal without resorting to redistributive taxation. Here are some examples of policies that could be examined to achieve such goals:[7]

[7] This discussion is based on Colander (2014). The ideas here are not tied to taking a complexity

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1. Property rights could be more limited in duration. Patent and copyright laws could be designed for shorter periods, so that benefits could be passed on more quickly to the broader public. This could include: (a) significantly limiting intellectual property rights; (b) encouraging institutions that favor open source software and material; and (c) issuing 100-year leases on land, instead of perpetuity property rights, so that land would revert to social wealth and be re-leased when the lease comes due.
2. Competition could be more strongly supported by limiting government-based monopolies: (a) Regulatory structures of institutions could allow for narrower specialists, so that the rents created are spread more widely and more competition is created. (b) Open certification that does not require specific high-priced formal training programs but rather "open-to-anyone" certification exams could be instituted. (c) At-risk students could be provided with a "bottom-up" educational option, in which they would receive the money that would have gone into educating them, if they learn the material on their own.
3. Individuals' social, not materialistic, proclivities could be encouraged: (a) Society could advocate and support a stronger tradition of social responsibility of the rich, so that achieving social goals becomes a favored luxury good. Andrew Carnegie's *gospel of wealth* could be built into the fabric of society. (b) Institutions could be designed to encourage social benefit, rather than private benefit entrepreneurship. (c) Materialism embedded in the GDP goals could be countered by replacing GDP with other measures of social success, such as Sen's Capabilities Index.

Conclusion

For most economists, complexity economics has little effect on their workaday applied policy economics. However, complexity economics has the potential to make an enormous difference in applied policy workaday economics by leading economists to a different way of framing policy—one that sees their work not as applied science, but as engineering.

Creative design engineering involves asking big questions that go beyond those that we can address in science. Examples include: What happens to effective policy if tastes are endogenous? How would an economy function with a different set of property rights? How might we change laws to make "for-benefit" institutions more prevalent? What institutional setup might lead to what society would see as a fairer distribution of income? An engineering approach

view, but taking such a view is much more likely to lead economists to make such policies a central focus of their research. For a nice discussion of problems with existing policy toward property rights, see Boldrin and Levine (2010) as well as Doctorow (2014).

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allows us to explore different answers to these big questions by changing them into real-world policy questions, which can then be answered with existing computational and analytic technology.

Economists have failed society because they have not done this. By allowing their policy discussion to be guided, without explicit consideration, by the WGE policy frame, economists have stopped asking the big questions that might have been intractable when the WGE frame was first adopted, but which are no longer intractable. Economic policy has not kept up with analytic and computational technology. They have missed asking obvious policy questions. The exploration of policy within a broader complexity frame will open up new avenues for economic policy analysis.

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