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Central banks of the forest

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It recently came as a surprise to learn that the world's largest living organism is neither a plant nor an animal. Rather it is somewhere in between a plant and an insect. Living beneath Malheur National Forest in Oregon USA, the largest known specimen weighs more than 35 000 tonnes, covers an area larger than 9 square kilometers and is thought to be over 2000 years old. If this sounds like something from 'The Upside Down' in the TV series Stanger Things you might not be too far wrong. This massive, ancient organism is a type of forest fungus commonly known as the Honey Fungus.

What is perhaps even more remarkable than its massive size and extraordinary age is its evolutionary success as a master allocator of resources. To succeed over time and to maintain an enormous bulk, while also being somewhat immobile, requires that every drop of water and every ounce of nutrients is used optimally, season to season and century to century. To complicate things, none of this happens in a stable or highly controlled environment but rather in a highly interdependent and sometimes volatile network of fungi, plants and animals operating on or beneath the forest floor, all of which have the potential to add-to or detract-from both the available resources, and the efficiency with which they are used over time. The Honey Fungus' success in this complex environment surely holds secrets for other resource allocators and could push the envelope for biomimicry from the hard sciences (like engineering) toward the soft sciences like economics and politics.

For many of us biomimicry conjures up mental images of cellphone towers shaped like trees or military aircraft with bird-inspired wings. There have even been a few magazine articles about town planners and civil engineers using fungus to help them with spatial planning. Fascinating case studies include the London Underground and Tokyo subway where engineers built scale models of the cities in a petri dish by placing oatmeal particles in the same formation as the cities' transport nodes. Large nodes were given more oats while small nodes were given fewer. They then introduced fungus into the petri dish, added moisture and warmed it up. The fungi grew towards each of the oat nodes, building connections between them so that they could feed on the oats in the most efficient manner while still growing and extending their fibers to reach all of the nodes. The resulting network of fungi threads provided an almost perfectly efficient map of the cities' transport networks, catering both to the local geography and to the amount of traffic represented by each oat node. Through simply observing the resource allocation and growth strategies used by fungi, town planners have been able to cross-check their own work as well as get new ideas on how to optimise future plans.

Now deeper insights into 'decisions' taken by fungi in complex systems have extended the potential for biomimicry even further. In more complex interdependent systems, the success of the Honey Fungus and others like it stems from its ability to not only feed on a network of host plants, but also from a remarkable ability to selectively feed and nourish plants in return. In The Hidden Life of Trees Peter Wohlleben describes how trees can double their amount of "life-giving nitrogen and phosphorous" through cooperating with a fungal network. Wohlleben outlines how different plants experience different light and growing conditions, or access to nutrients and water without which their growth would be impaired. Through cooperating with a fungal network, stronger plants can make donations to the available pool of water and nutrients on the forest floor which may in turn be drawn upon by other plants experiencing less abundant resources. This resource allocation mechanism involves a network of plant roots which is intermediated by fungus that provides the 'plumbing' for the transfer of resources from one plant root to another. In a memorable example, the author describes how a tree stump in one of the forests that he manages was sustained for hundreds of years through tapping into the nutrient flows within the fungal network even though the stump itself had no leaves or ability to photosynthesize for centuries.

Now new research is showing that the distribution of nutrient resources within, and by, fungal networks is not one-size-fits-all philanthropy but is based on sophisticated and highly selective strategies. In a research paper, Carl Fellbaum and his colleagues have shown that fungi have resource allocation strategies informing the amount of nutrients and water to share

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with whom and when. It was originally thought that plants with a surplus of water or nutrients simply make donations to the fungal network which would then pool these resources for other plants to tap into where needed. However, Fellbaum and his colleagues show that reality is a bit more complex and in fact, both plants and connecting fungi employ selective resource allocation strategies rather than simply just pooling and sharing resources indiscriminately.

In their experiment, the researchers monitored the growth of connecting fungi in different laboratory conditions. In the 'control group' fungi were grown in the same pot as two well-watered and well-nourished plants with plenty of sunlight. In this group, the fungi grew a similar number of threads around both plants which implied a more or less equal distribution of resources between them. In the next group, fungi were grown with two plants where one had adequate nutrients and sunlight while the other did not. In this example the fungi growth showed a preference for the stronger plant but still grew around the roots of the weaker plant, although to a lesser extent than the stronger plant, and still delivered some nutrients to the weaker plant to sustain it, although never enough for it to thrive at the expense of the stronger plant. This approach could be described as a 'tough-love' strategy. In the third example fungi was grown with two nutrient-deprived weak plants. In this experiment, the fungi used the available resources to modestly grow around both pairs of plant roots equally although, albeit to a lesser extent than the experiments with healthy plants. In contrast with the other experiments, this third approach simply employed a 'rainy-day' strategy where the fungi seemed to be positioning themselves to grow if and when conditions improved.

The different outcomes across each of these groups compellingly suggest that fungi adopted selective strategies for their interactions with the plants depending on circumstances. Crucially the fungi made 'though-love' and 'rainy-day' decisions to place themselves and their plants in the best position for success not only under the prevailing conditions but also for potentially changing conditions. This is specifically shown in its handling of the weaker plants in the experiments where they continued to allocate resources to them, albeit in a manner that also helped ensure its (and their) future access to resources if and when conditions should change.

If one thinks about economic resources playing a similar role in our societies to water and nutrients in the forest floor, these fungi experiments give rise to some interesting questions. The way economic activity evolves and develops demonstrably results in uneven distributions of economic nutrients across generations, geographies, social strata and industries. As a result of this, the allocation of resources to households and businesses is at the top of many national and regional policy agendas, placing a lot of pressure on the institutions in charge of helping to allocate resources.
Here the role of central banks and governments comes into sharp focus. Sometimes the challenges that they experience in trying to optimize resource allocation are eclipsed by the constraints imposed on them by society itself. Unlike fungi, these institutions are fundamentally politicized and subjected to political interference, lobbying and democratic processes – all of which limit their abilities to implement objective and selective resource allocation strategies. For example, a tough-love strategy is a lot more difficult for even fiercely independent institutions to implement when it is likely to lose an election.

Ironically this may render central banks and governments more mindless, less deliberate and less effective than their forest counterparts. However, the resource allocation strategies of fungi might still provide both central banks and governments with important clues and role-models for improving their resource allocation decisions over time. In the short term more selective and less politically constrained resource allocation decisions may seem almost impossible but perhaps in the long run they are not. The oldest central bank was formed in Sweden in 1668. At this time our Malheur Honey Fungus was already a teenager at 1500 years old and its ancestors had been around for millions of years. By these standards, Central Banks are in their infancy and probably deserve a bit more time to perfect their art. In the meanwhile, one can probably bank on more selective resource allocation strategies holding the keys to future policy toolkits for long-run prosperity.