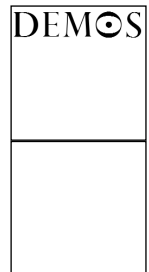


Disparities of
wealth appear as a
law of economic
life that emerges
naturally as an
organisational
feature of a
network . . .

**The science of
inequality**

Mark Buchanan



8. The science of inequality

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Historically, economists have been obsessed with arguments over how equitable or inequitable the distribution of wealth is among individuals. This is perhaps the most controversial and inflammatory of all economic topics. As economist John Kenneth Galbraith noted in his history of the field: ‘The explanation and rationalization of the resulting inequality has commanded some of the greatest, or in any case some of the most ingenious, talent in the economics profession.’¹

What is this ‘inequality’ that Galbraith refers to? We all know, of course, that a few people are very wealthy and that most of us have far less. But the inequality of the distribution of wealth has a surprisingly universal character. You might well expect the distribution to vary widely from country to country, as each nation has its own distinct political organisation and resources – some nations relying on agriculture, others on heavy industry – while their peoples have unique cultural expectations, habits and skills. However, towards the end of the nineteenth century, an Italian engineer-turned-economist named Vilfredo Pareto discovered a pattern in the distribution of wealth that appears to be every bit as universal as the laws of thermodynamics or chemistry.

Suppose that in Britain, China or the United States, or any other country for that matter, you count the number of people worth say, £10,000. Suppose you then count the number worth £20,000, £30,000 and so on, covering many levels of wealth both large and small, and

finally plot the results on a graph. You would find, as Pareto did, many individuals at the poorer end of the scale and progressively fewer at the wealthy end. This is hardly surprising. But Pareto discovered that the numbers dwindle in a very special way: towards the wealthy end, each time you double the amount of wealth, the number of people falls by a constant factor.

Big deal? It is. Mathematically, a ‘Pareto distribution’ of this form has a notable characteristic, as it implies that *a small fraction of the wealthiest people always possesses a lion’s share of a country’s riches*. It could be the case that the bulk of humanity in the middle of distribution was in possession of most of the wealth. But it isn’t so. In the United States something like 80 per cent of the wealth is held by only 20 per cent of the people, and the numbers are similar in Chile, Bolivia, Japan, South Africa or the nations of Western Europe. It might be 10 per cent owning 90 per cent, 5 per cent owning 85 per cent, or 3 per cent owning 96 per cent, but in all cases, wealth seems to migrate naturally into the hands of the few. Indeed, although good data is sadly lacking, studies in the mid-1970s based on interviews with Soviet emigrants even suggested that wealth inequality in the communist Soviet Union was then comparable to that of the UK.²

An underlying order?

What causes this striking regularity across nations? Does it simply reflect the natural distribution of human talent? Or, is there some devilish conspiracy among the rich? Not surprisingly, given the strong emotions stirred by matters of wealth and its disparity, economists in the past have, as Galbraith noted, flocked to such questions. Today, these questions again seem quite timely, as, if anything, the degree of inequity seems to be growing.

In the United States, according to economist Paul Krugman:

The standard of living of the poorest 10 percent of American families is significantly lower today than it was a generation ago. Families in the middle are, at best, slightly better off. Only the wealthiest 20 percent of Americans have achieved income

growth anything like the rates nearly everyone experienced between the 1940s and early 1970s. Meanwhile, the income of families high in the distribution has risen dramatically with something like a doubling of real incomes of the top 1 percent.³

A similar story could be told for the United Kingdom and many other countries, especially in Eastern Europe, over the past two decades.

Something similar is taking place on the global stage. Globalisation is frequently touted – especially by those with vested economic interests such as multinational corporations and investment banks – as a process that will inevitably help the poor of the world. To be sure, greater technological and economic integration on a global scale certainly ought to have the potential to do so. Yet as Nobel Prize-winning economist and former chief economist of the World Bank Joseph Stiglitz notes in his recent *Globalization and its Discontents*:

A growing divide between the haves and the have-nots has left increasing numbers in the Third World in dire poverty, living on less than a dollar a day. Despite repeated promises of poverty reduction made over the last decade of the twentieth century, the actual number of people living in poverty has actually increased by almost 100 million. This occurred at the same time that total world income actually increased by an average of 2.5 per cent annually.⁴

What is the origin of these distinct but seemingly related trends? Economists can, of course, offer a great many relevant observations. Stiglitz condemns the international economic policies of the Western nations and the International Monetary Fund as reflecting the needs of special financial and commercial interests regardless of the damage inflicted on the developing nations. One can point also to tax cuts for the very wealthy (a general theme of the 1980s and 1990s, especially in the US and UK), to changes in international markets, the influence of new communication technologies and so on. These are all legitimate and insightful points.

But might there be a more general perspective – a general science that would illuminate the basic forces that lead to wealth inequality? Conventional economic theory has never managed to explain the origin of Pareto’s universal pattern. Ironically, however, a pair of physicists, venturing across interdisciplinary lines, has recently done so. To understand their thinking, forget for the moment about personal ingenuity, intelligence, entrepreneurial skills and the other factors that might clearly influence an individual’s economic destiny. Instead, take one step into the abstract and think of an economy as a network of interacting people and focus on how wealth flows about in this network.

That’s the way the money goes

Each of us has a certain amount of wealth and, over the days and weeks, this amount changes in one of two fundamental ways. Your employer pays you for your work; you buy groceries; you build a fence to keep in the dog; you take a holiday in Tuscany. Transactions of this sort form the bread-and-butter of our daily economic lives, and serve to transfer wealth from one person to another along the links in the network. This is one mechanism by which our wealth goes up or down.

When wealth flows from one person to another, however, the total amount doesn’t change. And yet wealth can also be created or destroyed. Say you purchased a house in the UK in 1995. Today, you are probably happy to see that its value has skyrocketed in the recent real-estate boom. Your total wealth has gone up. On the other hand, in 1998, you may have invested some spare cash into the stock market – perhaps even buying shares in Enron or Worldcom – and gone on to read the daily newspapers with a sense of unfolding doom. Investments lead both to the creation and the destruction of wealth.

From this extremely simple perspective, then, two basic factors control the dynamics of wealth. This is hardly contentious, and it may also seem unworthy of consideration. Yet, as physicists Jean-Philippe Bouchaud and Marc Mézard of the University of Paris have recently

shown, the interplay of these two basic forces goes a long way to determining how wealth is distributed.⁵

For a network of interacting individuals, Bouchaud and Mézard formulated a set of equations that could follow wealth as it shifts from person to person, and as each person receives random gains or losses from his investments. They also included one further feature to reflect the fact that the value of wealth is relative. A single parent trying to work and raise her son might face near ruin over the loss of a £20 note; in contrast, a very rich person wouldn't flinch after losing a few thousand. In other words, the value of a little more or less wealth depends on how much one already has. This implies that when it comes to investing, wealthy people will tend to invest proportionally more than the less wealthy.

The equations that capture these basic economic processes are quite simple. However, there is a catch. For a network of many people – say, 1,000 or more – the number of equations is similarly large. For this reason, a model of this sort lies well beyond anyone's mathematical abilities to solve (and this explains why it has not appeared in conventional economics). But the philosopher Daniel Dennett has for good reason called digital computers 'the most important epistemological advance in scientific method since the invention of accurate timekeeping devices' and Bouchaud's and Mézard's work falls into a rapidly growing area known as 'computational economics' which exploits the computer to discover principles of economics that one might never identify otherwise.

Bouchaud and Mézard explored their model in an exhaustive series of simulations. And in every run they found the same result – after wealth flows around the network for some time, it falls into a steady pattern in which the basic shape of wealth distribution follows the form discovered by Pareto. Indeed, this happens even when every person starts with exactly the same amount of money and money-making skills. This pattern appears to emerge as a balance between two competing tendencies.

On the one hand, transactions between people tend to spread wealth around. If one person becomes terrifically wealthy, he or she

may start businesses, build houses and consume more products, and in each case wealth will tend to flow out to others in the network. Likewise, if one person becomes terrifically poor, less wealth will flow through links going away from him, as he or she will tend to purchase fewer products. Overall, the flow of funds along links in the network should act to wash away wealth disparities.

But it seems that this washing-out effect never manages to gain the upper hand, for the random returns on investment drive a counter-balancing 'rich-get-richer' phenomenon. Even if everyone starts out equally, and all remain equally adept at choosing investments, differences in investment luck will cause some people to accumulate more wealth than others. Those who are lucky will tend to invest more and so have a chance to make greater gains still. Hence, a string of positive returns builds a person's wealth not merely by addition but by multiplication, as each subsequent gain grows ever bigger. This is enough, even in a world of equals where returns on investment are entirely random, to stir up huge wealth disparities in the population.

This finding suggests that the basic inequality in wealth distribution seen in most societies – and globally as well, among nations – may have little to do with differences in the backgrounds and talents of individuals or countries. Rather, the disparity appears as a law of economic life that emerges naturally as an organisational feature of a network. This finding suggests that the temptation to find complex explanations behind the distribution of wealth may be seriously misguided.

Altering inequality

However, this does not imply that there is no possibility for mitigating inequities in wealth. There is some further subtlety to the picture. From an empirical point of view, Pareto found (as many other researchers have found later) that the basic mathematical form of the wealth distribution is the same in all countries. One always finds that each time you double the amount of wealth, the number of people having that much falls by a constant factor. This is the pattern that always leads to a small fraction of the wealthy possessing a large

fraction of everything. Nevertheless, the ‘constant factor’ can be somewhat different from one case to another. The degree of inequity can vary from country to country, and, socially speaking, there’s a huge difference between the richest 5 per cent owning 40 per cent of the wealth or their owning 95 per cent.

An additional strength of Bouchaud’s and Mézard’s network model is that it shows how the degree of inequity in an economy can be altered. They found two general rules. First, the greater the volume of wealth flowing through the economy – the greater the ‘vigour’ of trading, if you will – then the greater the equality. Conversely, the more volatile the investment returns, the greater the inequity. This has some curious practical implications – some obvious and some not so obvious.

Take taxes, for instance. The model confirms the assumption that income taxes will tend to erode differences in wealth, as long as those taxes are redistributed across the society in a more or less equal way. After all, taxation represents the artificial addition of some extra transactional links into the network, along which wealth can flow from the rich towards the poor. Similarly, a rise in capital gains taxes will also tend to ameliorate wealth disparities, both by discouraging speculation and by decreasing the returns from it. On the other hand, the model suggests that sales taxes, even those targeted at luxury goods, might well exaggerate differences in wealth by leading to fewer sales (thus reducing the number of transactional links) and encouraging people to invest more of their money.

The model also offers an excellent test of some arguments that politicians use to justify policies. In Britain and in the United States, for example, the 1980s and 1990s were dominated by free-market ideology, much of it defended by the idea that wealth would ‘trickle down’ to the poor. Everything was done to encourage investment activity, regardless of the risks involved. This was the era of junk bonds, the savings and loan debacle, and the dot-com boom, now capped off by the Enron-led wave of corporate scandals. As we know, the wealth did not trickle down and the distribution of wealth in both countries is today significantly less equitable than it was three decades

ago. Under the network model, this is just what one would expect – a dramatic increase in investment activity, unmatched by measures to boost the flow of funds between people, ought to kick up an increase in wealth inequality. (Indeed, taxes were also generally lowered during this era, thus removing some of the links that could have helped to redistribute wealth.)

What about globalisation? From the perspective of this model, international trade should offer a means to create a better balance between the richer and poorer nations. Leaving aside legitimate concerns over a lack of environmental regulations, protection for child labourers and so on, Western corporations setting up manufacturing plants in developing nations and exporting their computing and accounting to places like India and the Philippines should help wealth flow into these countries. In some cases, this promise of globalisation has been realised. But, in view of the potential benefits, it is easy to understand the anger of the poorer nations at measures designed to skew the trading network in favour of the richer countries. As Stiglitz comments:

The critics of globalization accuse Western countries of hypocrisy, and the critics are right. The Western countries have pushed poor countries to eliminate trade barriers, but kept up their own barriers, preventing developing countries from exporting their agricultural products and so depriving them of desperately needed export income...The West has driven the globalization agenda, ensuring that it garners a disproportionate share of the benefits, at the expense of the developing world.⁶

As Bouchaud's and Mézard's model illustrates, free trade could be a good thing for everyone, but only if it enables wealth to flow in both directions without bias.

But let's go back to the model, for it also reveals another rather alarming prospect. In further investigations, Bouchaud and Mézard found that if the volatility of investment returns becomes sufficiently

great, the wealth differences it churns up can completely overwhelm the natural diffusion of wealth generated by transactions. In such a case, an economy – whether within one nation, or more globally – can undergo a transition wherein its wealth, instead of being held by a small minority, condenses into the pockets of a mere handful of super-rich ‘robber barons’.

It is intriguing to wonder if some countries, particularly developing nations, may already be in this state. It has been estimated, for example, that the richest 40 people in Mexico have nearly 30 per cent of the wealth. It could be, also, that many societies went through this phase in the past. Long-term economic trends during the twentieth century lend some credence to this idea, as the total share of the richest individuals in England, for example, has fallen over the last century.

In Russia, following the collapse of the USSR, wealth has become spectacularly concentrated; inequality there is dramatically higher than in any country in the West. The model would suggest that both increased investment volatility and lack of opportunities for wealth redistribution might be at work. In the social vacuum created by the end of the Soviet era, economic activity is less restricted than in the West, as there are few regulations to protect the environment or to provide safety for workers. This not only leads to pollution and human exploitation but also generates extraordinary profits for a few companies (the politically well connected, especially – a popular pun in Russia equates privatisation with the ‘grabbing of state assets’). Economists have also pointed out that Russia has been slow to implement income taxes that would help to redistribute wealth.

This simple model is, of course, not the final word in explaining the distribution of wealth or how best to manage it. But it does offer a few basic lessons. Although wealth inequity may indeed be inevitable to a certain extent, its degree can be adjusted. With proper regulation to protect the environment and workers’ rights, free trade and globalisation should be forces for good, offering better economic opportunities for all. But we will achieve such happier ends only if global integration is carried out sensibly, carefully and, most of all,

honestly. If it is not, and if the disparity between the haves and have-nots continues to grow, then one might expect countervailing social forces to be stirred up, as they have throughout history.

By starting with remarkably simple assumptions and studying the patterns that emerge in a network of interacting agents, Bouchaud and Mézard have gained an important insight into one of the most basic – and contentious – patterns of economic life. Unfortunately, their model by itself cannot help us make wise use of this insight.

Mark Buchanan is a science writer. His most recent book is Small World: uncovering nature's hidden networks. A version of this essay first appeared in New Statesman.

Notes

- 1 J K Galbraith, *A History of Economics* (London: Penguin, 1991).
- 2 J Flemming and J Micklewright, 'Income distribution, economic systems and transition', Innocenti Occasional Papers, Economic and Social Policy Series, no 70 (Florence: UNICEF International Child Development Centre, 1999).
- 3 P Krugman, 'An unequal exchange' in *The Accidental Theorist* (New York: Norton, 1998).
- 4 J Stiglitz, *Globalization and its Discontents* (London: Allen Lane, 2002).
- 5 J-P Bouchaud and M Mézard, 'Wealth condensation in a simple model of economy', *Physica A*, 282 (2000).
- 6 Stiglitz, *Globalization and its Discontents*.