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Growing through Sabotage
Energizing Hierarchical Power

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Energizing Hierarchical Power

Shimshon Bichler and Jonathan Nitzan[1]

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[1] The impetus for writing this paper came from reading Blair Fix's path-breaking work on hierarchy, energy and growth (2015a, 2015b, 2017). We are indebted to Blair Fix and Daniel Moure for commenting on the first draft of the article – though responsibility for the final cut is of course ours alone. Shimshon Bichler teaches political economy at colleges and universities in Israel. Jonathan Nitzan teaches political economy at York University in Canada. All of their publications are available for free on *The Bichler & Nitzan Archives* (http://bnarchives.net). Research for this paper was partly supported by the SSHRC.

Abstract

According to the theory of capital as power, capitalism, like any other mode of power, is born through sabotage and lives in chains – and yet everywhere we look we see it grow and expand. What explains this apparent puzzle of 'growth in the midst of sabotage'? The answer, we argue, begins with the very meaning of 'growth'. Whereas conventional political economy equates the growth with a rising standard of living, we posit that much of this growth has nothing to do with livelihood as such: it represents not the improvement of wellbeing, but the expansion of sabotage itself. Building on this premise, the article historicizes, theorizes and models the relationship between changes in hierarchical power and sabotage on the one hand and the growth of energy capture on the other. It claims that hierarchical power is sought for its own sake; that building and sustaining this power demands strategic sabotage; and that sabotage absorbs a significant proportion of the energy captured by society. From this standpoint, capitalism grows, at least in part, not despite or because of sabotage, but *through* sabotage.

1. Introduction

The theory of capital as power, or CasP, argues that capitalism, like other historic societies, is best examined not as a mode of production and consumption, but as a *mode of power*.[2] To think of society as a mode of power is to focus, first and foremost, on the institutions and processes that articulate and determine social power. Production and consumption are of course important to this articulation and determination – but not exclusively and often inversely.

The key CasP question is what *creorders* – or creates the order of – a mode of power. Power and resistance to power, we have argued in our work, are dialectically intertwined: without power there could be no opposition to power, and without opposition to power, whether blatant or latent, there would be nothing to exert power over in the first place. The two forces imply, negate and generate each other in an infinite regress. Now, when we speak of society as a mode of power, we describe a social order in which power is able to suppress and prevail over resistance to power, and this ability, we maintain, implies and requires what Thorstein Veblen called *strategic sabotage*. In order for power to successfully harness, contain and, if necessary, crush resistance, the powerful must constantly restrict, limit and inhibit the autonomy of those with less or no power. Moreover, they must do so strategically: applying too little sabotage might be insufficient to sustain their power, while inflicting too much can trigger revolt or, worse still, decimate the very fabric of society they seek to control.[3]

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[2] The fullest account of CasP is offered in Nitzan and Bichler (2009). Shorter overviews and interviews can be found in Bichler and Nitzan (2012a), Bichler, Nitzan and Di Muzio (2012) and Bichler, Nitzan and Dutkiewicz (2013). Bichler and Nitzan (2015b) survey the past, present and future of CasP research, while Debailleul, Bichler and Nitzan (2016) articulate some implications.

[3] Note that our notion of strategic sabotage here is broader and somewhat different than Veblen's. Writing at the turn of the twentieth century, Veblen's main focus was the pecuniary institutions of 'business' and the ways in which these institutions undermined the universal efficiency of 'industry' for redistributional ends. In this sense, his conception of sabotage was largely confined to the 'economic' sphere of production and consumption, investment and waste, credit and finance. The CasP approach, although partly influenced by Veblen, transcends the politics-economics duality from the beginning and is therefore able to conceive of sabotage not as an economic tool, but as a lever of power more generally.

This broader viewpoint reveals significant historical changes in the nature and application of strategic sabotage. In the ancient states (as well as in prehistoric societies), power was usually exerted openly, directly and violently, and often in ways that seemed arbitrary and random. In later, more complex polities, however – and particularly in modern capitalism – this exertion became much more opaque and

Now, although the nature and impact of strategic sabotage varies significantly from one mode of power to another, there are also broad similarities. In all pre-capitalist modes of power, strategic sabotage tended to be associated with a fairly rigid societal structure, a relatively stable culture and little or no growth in production and consumption. Compared with this record, the capitalist mode of power marks an epochal novelty: it represents not only the first historic society that is both dynamic and growing, but also the first whose dynamism and growth seem inherent to its very logic.

1.1 Energy Capture

The historical record on this matter is unambiguous: over the past three centuries, the structure of capitalism has been constantly transformed, its population count gone vertical and its per capita energy soared to unprecedented levels. The uniqueness of capitalism in this regard is illustrated in Figure 1 and Table 1.

The figure plots the evolution of the world's *overall energy capture* and its components from 10000 BCE to the present. The term 'energy capture' here denotes the entire range of energy types converted by human society. The energy sources inputted into – or 'captured' by – this conversion include biomass, various fuels and different raw materials, while the outputs comprise human and animal feed, heating and cooling, material and immaterial objects, physical and virtual transportation – and, last but not least, the energy lost to the conversion process itself (Cook 1971; Morris 2013: 53).

Analytically, we can conceive of overall energy capture as the product of two components: the *breadth of energy capture*, measured by the size of the population, and the *depth of energy capture*, measured by energy capture per person.[4]

1. $$overall\ energy\ capture = population\ \times energy\ capture\ per\ capita$$

$$= breadth\ of\ energy\ capture\ \times depth\ of\ energy\ capture$$

The figure shows the evolution of these three energy-capture series – depth, breadth and overall – between 10000 BCE and 2000 CE. The series are rebased with 10000 BCE = 1.0 for easier visualization. They are also plotted against a logarithmic scale, so their relative slopes are proportionate to their respective growth rates. Now, although the underlying data are only rough approximations, the overall picture they portray is clear enough.

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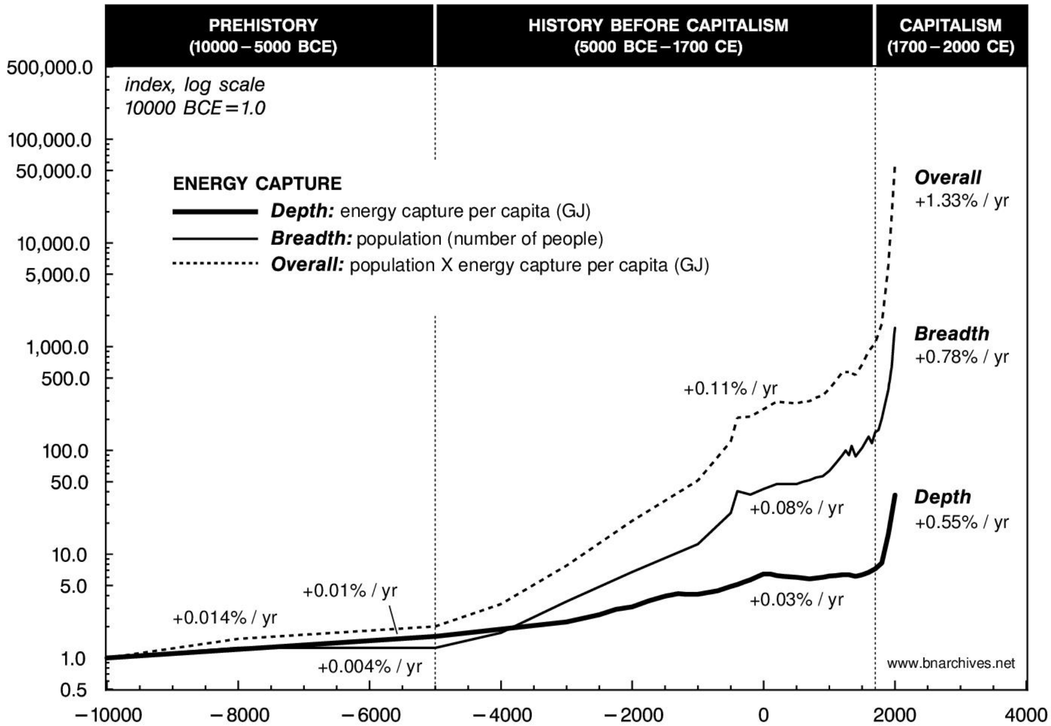
roundabout, far less violent and significantly more systematic. In this latter constellation, sabotage is less open and more stealthy: instead of acting positively to affirm and assert the will of the powerful, it operates mostly negatively, by preventing, restricting and undermining the actions of those polities' subjects. It also grows less violent: instead of using brute force, it often resorts to temptation, manipulation, mental pressure and inbuilt guilt. Finally and crucially, it becomes more methodical: instead of yielding to whim and caprice, it progresses deliberately and calculatedly.

[4] Our notions of energy breadth and depth draw on and in some sense overlap with our analysis of capitalized power. In this analysis, breadth, measured by the organization's head count, represents the organization's size, while depth, measured by earnings or capitalization per capita, denote its power per 'unit of organization' (Nitzan 1992; Nitzan and Bichler 2009).

Figure 1: World Energy Capture



NOTE: Series are rebased with 10000 BCE = 1.0. Overall energy capture is the product of energy capture per capita (Depth) and population (Breadth). Energy capture per capita is the arithmetic mean of Ian Morris's estimates for Western and Eastern energy capture per capita. The yearly growth rates next to the series represent geometric means for the relevant periods.

SOURCE: World energy capture per capita is from Ian Morris (2013), *The Measure of Civilization*: Table 3.1 (p. 61) for Western estimates and Table 3.4 (p. 111) for Eastern estimates. World population is from the US Census Bureau's tables: 'Historical Estimates of World Population' for 10000 BCE to 1940 (middle estimate for 10000 BCE; lowest estimates for the rest; goo.gl/VeH4YS) and 'World Population' for 1950 to 2000 (mid-year estimates; goo.gl/RvrjLn); both tables were accessed on June 18, 2017.

Table 1: Annual Growth Rates of World Energy Capture (geometric means)

	Depth (energy capture per capita)	**Breadth** (population)	**Overall** (Depth × Breadth)
1. Prehistory 10000–5000 BCE	+ 0.01% / yr *doubles every 6,932 years*	+ 0.004% / yr *doubles every 17,329 years*	+ 0.014% / yr *doubles every 4,951 years*
2. History Before Capitalism 5000 BCE–1700 CE	+ 0.03% / yr *doubles every 2,311 years*	+ 0.08% / yr *doubles every 867 years*	+ 0.11% / yr *doubles every 630 years*
3. Capitalism 1700–2000 CE	+ 0.55% / yr *doubles every 126 years*	+ 0.78% / yr *doubles every 89 years*	+ 1.33% / yr *doubles every 52 years*
Ratio of Growth Rates period 3 ÷ period 2	18.3	9.8	12.1
Ratio of Doubling Time period 3 ÷ period 2	0.055	0.103	0.083

Source: Figure 1

Most generally, they show three distinct periods: (1) prehistory (till 5000 BCE), (2) history before capitalism (5000 BCE–1700 CE), and (3) capitalism (1700–2000 CE).[5] During the prehistoric period, the breadth and depth of energy capture – and therefore its overall volume – changed by very little, if at all (remember through that the data here are very sketchy). The initial acceleration came roughly around 5000 BCE, with the emergence of the early historical modes of power. For the first time in the history of their species, human beings found themselves buckled by hierarchical state structures, and as these structures spread, the depth and breadth of energy capture – and hence its overall volume – started to increase.

But the increase was almost imperceptible. Between 5000 BCE and 1700 CE, the depth of energy capture expanded at an annual average rate of only 0.03 per cent. At that rate, it took depth *more than two millennia* to double in size (see Table 1). The average annual growth rate of breadth, at 0.08 per cent, was nearly three times faster, while the growth of overall energy was pitched even higher, at 0.11 per cent. But even at those faster rates, doubling time was still half a millennium or more.

All of this changed, and rather dramatically, with the rise of capitalism. During the 1700-2000 period, the depth of energy capture grew at an average annual rate of 0.55 per cent – more than 18 times faster than during the previous 6,700 years. The social impact of this change was enormous. In the period between 5000 BCE and 1700 CE, it took the depth of energy capture 2,311 years to double; in capitalism, this doubling period was cut down to 126 years (Table 1). A 75-year-old person living during the historical period prior to capitalism would have witnessed energy capture per capita expand by a mere 2.3 per cent over her entire lifetime; in capitalism, a similar person would see this capture rise by as much as 51 per cent! The capitalist acceleration of breadth and overall energy capture were equally dramatic: the former grew at an average rate of 0.78 per cent annually (nearly 10 times faster than during the historical period before capitalism), while the later rose by an average of 1.33 per cent per year (12 times faster).

1.2 The CasP Puzzle

All in all, then, it is clear that, in terms of energy capture, historical modes of power were fairly stationary up until the rise of capitalism and explosive thereafter. And here arises a CasP puzzle. Rousseau famously observed that 'Man is born free, and everywhere he is in chains', and the same observation can be made about capitalism – only in reverse. According to CasP, capitalism, like any other mode of power, is born through sabotage and lives in chains – and yet everywhere we look we see it grow and expand.

How can we explain this apparent contradiction? If capitalism is indeed crisscrossed with various forms of strategic sabotage, why is it that, unlike other modes of power, it remains dynamic and growing? Maybe the notion of 'capitalist sabotage' is a misnomer to begin with? Indeed, according to many writers, the very growth of capitalist societies attests to their democracy and autonomy – just as the very stagnation of traditional societies demonstrates their authoritarianism and subjugation (Huntington 1968). And if that is indeed the case, should we not conclude that capitalist sabotage – assuming there is any – is simply too limited to arrest the system's inherent growth drive? Or maybe we are misinterpreting the very nature of capitalist growth and

[5] Our choice of 1700 as the 'beginning' of capitalism is practical rather than theoretical: regardless of its precise birthday, until 1700 capitalism was simply too limited in scope to have a significant impact on the world's average rate of growth.

change? Is capitalism indeed unable to exert power – or can it be that, in capitalism, growth itself is a lever of power?

Our purpose in this paper is to examine this apparent puzzle of 'growth in the midst of sabotage', and our tentative conclusion is that there is in fact *no puzzle at all*. The conventional view, both mainstream and heterodox, is that capitalism is a system driven by the growth of production and consumption, and that, short-term crises and the ups and downs of redistribution aside, this growth is ultimately about wellbeing. The very vocabulary of economics determines this conclusion: since the economy is said to produce and consume 'goods' and 'services', its growth is equivalent to a rising 'standard of living', by definition.

But as we shall show, this habit of thinking might be deeply misleading. And why? Because a significant proportion of these so-called goods and services have nothing to do with livelihood: their growth represents not the improvement of wellbeing, but the expansion of sabotage itself. And if that is in fact the case, it follows that capitalism grows, at least in part, not despite or because of sabotage, but *through* sabotage.

The paper comprises twelve sections. The two sections following this introduction set the stage. Section 2 outlines the CasP claim that capitalized power is augmented by *undermining* efficiency and growth, while Section 3 presents the opposite notion – namely, that hierarchical power is in fact the best way of *boosting* them. The remainder of the article tries to sort out this apparent contradiction. Section 4 begins by examining the connection between power and hierarchy more closely, Section 5 continues by contrasting hierarchy and power on the one hand with cooperation and symbiosis on the other and Section 6 assesses how their interaction might have affected the evolution of society. Section 7 considers the respective capacities of hierarchical power and autonomous cooperation to 'capture energy' and the difficulty of measuring these capacities in practice, while Section 8 explores why hierarchy requires energy at all. Using and extending these analyses, Sections 9 to 11 outline an alternative hierarchy-energy model, delineating and exploring the four hierarchy-energy trajectories a mode of power can follow: expansion, crisis and decline on the one hand, and democratization on the other. Section 12 offers a summary, reflections and extensions.

2. Capitalized Power and Economic Growth

2.1 Sabotage

Begin with notion of capitalized power and the imperative of strategic sabotage. According to CasP, capitalist power is quantified through *differential capitalization*. Each owned entity is capitalized by the risk-adjusted present value of its expected earnings, and the power that this capitalization represents is gauged by relating it to the capitalization of other entities, groups of entities or society as a whole. Capitalized entities, subjugated to the imperatives of power, are driven to accumulate not absolutely but *differentially*. Their aim is not to get more wealth per se, but to *beat* the average and *exceed* the normal rate of return. They seek to expand not faster but *faster than others*, to get not the maximum amount of income and wealth but a *bigger share of the total*. Now, since in the world of capitalized power attempts to beat the average and redistribute profits and assets are inherently conflictual, they always involve strategic sabotage. They require limitations, inhibitions and restrictions that boost one's own earnings and capitalization *relative* to – and often *by undermining* – those of others. And as the imperative of capitalized power spreads and proliferates throughout society, so do the various forms of strategic sabotage on which this power rests.

The CasP project has identified numerous such paths of differential accumulation through strategic sabotage. A partial list of these paths includes higher unemployment that redistributes income in favour of capitalists (Bichler and Nitzan 2014a); decelerating employment growth that shifts income in favour of the top 1% of individuals (Nitzan and Bichler 2014a) and assets in favour of the top 500 companies (Bichler and Nitzan 2016b); higher inflation that tends to undermine the standard of living and sense of security of the underlying population while redistributing income in favour of capital in general and dominant capital in particular (Nitzan and Bichler 2002, 2009); waves of mergers and acquisitions that hinder greenfield investment while redistributing income in favour dominant capital (Nitzan 2001); lower growth of plant and equipment that, contrary to received convention, accelerates the growth of market capitalization (Nitzan and Bichler 2009; Bichler and Nitzan 2015a); militarization and the bourgeoning arms trade that fuel conflict while redistributing income in favour of the leading military contractors (Bichler and Nitzan 2001; Nitzan and Bichler 2002, 2007); periodic Middle East energy conflicts that implode the region and destabilize the world while redistributing income in favour of oil-producing governments and the leading armament and petroleum firms (Nitzan and Bichler 1995; Bichler and Nitzan 1996, 2015c); the globalization of ownership that pits national populations against each other while boosting differential accumulation and deepening local and global inequalities (Nitzan and Bichler 2002; Park 2013, 2016; Park and Doucette 2016); rising food prices and higher food-price volatility that cause mass hunger in developing countries while raising the differential incomes of the world's leading grain-trading companies and large grain producers (Baines 2014, 2015, 2017); the widespread automation of investment algorithms that amplifies financial instability by leveraging the fear-and-greed cycle for differential gain (Nitzan and Bichler 2014b); the proliferation of junk food that fuels a global obesity epidemic while bloating the differential profits of food and pharmaceutical conglomerates (Albritton 2009; Bichler and Nitzan 2016a; Howard 2016); the growing restrictions on Hollywood's artistic autonomy that debilitate audiences while reducing the differential risk of the major studios (McMahon 2013, 2015); the apartheid regime in South Africa and the occupation of Palestine by Israel that for half a century underwrote the differential accumulation of gold-mining conglomerates in the former and military-financial holding groups in the latter (Nitzan 1996; Nitzan and Bichler 2001); the incarceration of a record number of Americans to secure the country's deepening income inequality (Bichler and Nitzan 2014b); the advertising that has entire societies dance to the capitalized tune of the advertisers (Cochrane 2015, 2016); the redistributive role of conspicuous consumption (Di Muzio 2015); the leveraging of government debt in favour of the top 1% and their leading corporations at the expense of the underlying population (Hager 2014, 2015; Di Muzio and Robbins 2016; Hager 2016); the financial deregulation that destabilizes the capitalist order while boosting the differential profits of the banking sector (Ostojić 2015a, 2015b); the list goes on and on.

The breadth and depth of these examples leave little doubt: capitalism is indeed born in chains and lives in shackles. Strategic sabotage is integral to its very logic and daily practice. Everywhere we look, we see capitalized power bound up with restrictions, inhibitions and limitations.

Now, with these chains and shackles in mind, we should expect capitalism to trip on its own bootstraps and be hamstrung by stagnation, recession and hardship. And in many ways it is. According to numerous CasP studies, higher capitalized power does tend to correlate with less dynamism and lower growth. But, then, the dynamism and growth, although curtailed, are *never entirely arrested*. While capitalism is probably less dynamic and slower to grow than it might be with fewer such impositions, in comparison to other modes of power it still sparkles and shines. What, then, is the source of this seemingly unique resilience? What is it that enables capitalism to transcend its own power-imposed sabotage and expand faster and more vigorously than any other social system?

2.2 Economies of Scale

Conventional political economists have tried to answer this question, but the way in which they pose it in the first place is so different than our own that a brief digression might be in order. According to the common view, both mainstream and heterodox, capital is an *economic* category, an entity denominated in units of production and consumption. In this framework, power and sabotage are 'non-economic' entities and therefore external to accumulation as such. In most models they are nowhere to be found. And on the rare occasion that they do make an appearance, they are introduced not as inherent forces, but as 'exogenous shocks' – uncalled-for 'distortions', 'interventions' and 'disturbances' that rattle the system from the *outside*.[6]

The distortions created by power institutions and processes are usually thought of as having two opposite effects – one negative, the other positive. On the negative side, power is said to undermine the proper working of the 'free market', frustrate the 'efficient allocation of resources' and hinder the production of goods and services, and these negative effects, goes the argument, make capitalism less 'productive' than it otherwise could be and cause growth to fall short of its 'full potential'. On the positive side, though, capitalist power facilitates the rise of large economic organizations, and as some market advocates painfully admit, larger organizations, particularly those driven by profit, are often more efficient than smaller ones. Market advocates might also concede that, under certain conditions, government power, although it distorts and undermines private efficiency, can end up boosting the *overall* efficiency of society by mitigating intra-societal conflict and sustaining aggregate demand.[7]

This double-sided impact of power had already been pointed out by Adam Smith and Karl Marx, but it was only in the early twentieth century, when the large corporation – along with big government and large labour unions – first came to its own, that the issue was addressed head on. One of the first to do so was Alfred Marshall (1920), who reluctantly conceded that the growth of large firms might upset the invisible hand and give rise to a corporate caste. But he also insisted that the attendant social inconvenience was nonetheless tolerable – first because a corporate caste would be benevolent, and second because large-scale business enterprise tends to be more technically efficient and its greater efficiency would more than outweigh its associated political and market costs. In his opinion, 'organization' – an attribute that big firms are particularly endowed with – was a 'distinct agent of production', on par with land, labour and

[6] The inverted commas in this and the following paragraph are meant to flag conventional concepts of which we are deeply critical. For a detailed examination, see Nitzan and Bichler (2009: Chs. 5-8).

[7] The term 'efficiency' denotes a ratio of the outputs to the inputs of a given process. Thermodynamic efficiency, for example, is the ratio of work output to energy input; technical efficiency is the ratio between economic outputs and economic inputs; economic efficiency is the monetary cost of producing a unit of output; societal efficiency is the ratio between social outputs and social inputs; labour efficiency is the ratio of labour outputs to labour inputs, etc. The precision of these concepts and our ability to actually measure them vary greatly (see footnote 23).

capital. And given that, according to Marshall, organization 'aids knowledge' and is 'our most powerful engine of production' (p. 115), it follows that, on balance, big business is good for society after all.

And that is not the end of it. According to Ronald Coase (1937), even if large organizations are not always more *technically* efficient (i.e., yielding higher output per unit of input), they still tend to be more *economically* efficient (producing at a lower cost).[8] One of the key reasons for this latter form of efficiency, Coase argued, is that large organizations are better able to save on 'transaction costs'. *Inter*-organizational transactions, he asserted, are subject to market discipline, which, according to the neoclassical scriptures, means they are the most technically efficient. Unfortunately, though, these transactions are not free, so they make sense only if their extra technical efficiency outweighs their additional cost; if it does not, the transactions, although more technically efficient, are economically inefficient and therefore better internalized as cheaper *intra*-organizational activity.

Using such calculus, it is then easy to determine – or so we are told – the 'proper' (read economically efficient) boundary of the organization. According to Coase, this boundary is set at the precise point where 'the costs of organizing an extra transaction within the firm become equal to the costs of carrying out the same transaction by means of an exchange on the open market or the costs of organizing in another firm' (1937: 395).

To make this opaque sentence more concrete, think of a McDonald's outlet. The boundary of the firm here is right at the service counter. And how do we know that? Because the employee at the cash register receives the hamburger from those who prepared it through an intra-organizational *transfer* (she just takes it from the rack) and then uses a market *transaction* to sell it to the customer standing on the other side of the counter (in return for money). According to Coase, these two facts mean that the transaction costs must be slightly higher than the internal costs for the first activity and slightly lower for the second, and this delicate balance-at-the-margin implies that the economically efficient boundary of McDonald's can be drawn by connecting the counters of its 37,000 restaurants. QED.[9]

And here lies the problem. Although popular, this delineation goes the wrong way: instead of using McDonald's actual transaction costs to predict its proper boundaries, it uses the company's actual limits to justify the theory of transaction costs. And as we follow this path, we end up going in a circle. Modern firms such McDonald's, ExxonMobil and Google are huge, presumably because their size helps them save on transaction costs. And how do we know they save on transaction costs? Well, obviously because they are . . . big!

Economists stick to this tautological defence of corporate size for many reasons, the most important of which is that they *have no choice*. And why not? Because, in practice, Marshall's

[8] Technical efficiency depends only on the relationship between outputs and inputs. Economic efficiency, measured by unit cost, depends on both technical efficiency and input prices.

[9] Coase's transaction-cost analysis was originally developed for business firms but has since been applied to the full spectrum of organizations – human and non-human alike. A recent simulation of the evolutionary origin of hierarchy argues that biological networks, from the level of organic molecules and up, become hierarchical only in the presence of what the authors call 'connection costs'. When there are no connection costs, claim the authors, these networks tend to develop flat structures (Mengistu *et al.* 2016). In other words, molecules, single-cell organisms and herds of mammals are just like the capitalists who own McDonald's: they all self-organize to minimize their transaction costs in their quest for maximum gain.

'organization' and Coase's 'transaction costs' are difficult if not impossible to quantify.[10] This opacity is theoretically costly. Since the inputs, outputs and costing of 'organization' remain elusive, we can say nothing concrete about the respective efficiencies of hierarchical power and the flat market, and this inability leaves us right where we started. We still need to explain why capitalism, although chained by hierarchical organizational power, remains dynamic and growing.

3. Hierarchy for Energy

3.1 Hierarchy as a Necessary Evil

A highly innovative attempt to sort out the puzzle is offered by Blair Fix (2015a, 2015b, 2017). Instead of the standard economic route, Fix takes a socio-biophysical one. The laws of thermodynamics, he points out, 'dictate that any system that exists far from equilibrium must be supported by a flow of energy', and since 'human societies are non-equilibrium systems, it follows that energy flows ought [to] play an important part in social evolution' (Fix 2017: 1).

According to Fix, economic growth, however measured, involves the conversion of energy, and the conversion of energy is always transformative. Economists tend to think of this transformation in terms of utility: energy from biomass, fossil fuel, light, wind, hydroelectric, thermal heat and nuclear power, among other sources, is converted into goods and services, and then again, via consumption, into wellbeing. But there is another aspect to this process that economists often ignore: when society transforms energy into goods and services, it also transforms its *own structures*.

In modern society, says Fix, this latter transformation is most evident with respect to the *size* of social organizations, measured by the number of employees.[11] He shows that growing energy capture per capita goes hand in hand with growing organization size, both absolutely and relative to society – or, using our own terminology, that the *depth* of energy capture is positively correlated with the *breadth* of society's largest organizations – and that this association is evident both in different countries and over time. Based on cross-country data, he demonstrates that higher energy capture per capita means that (1) fewer people are self-employed and more are working for large firms; (2) average firm size gets bigger; and (3) the government's share of total employment rises (Fix 2017: Figure 1, p. 4). These same conclusions are also evident temporally, particularly in the United States, where long-term time-series data enable us to trace the evolution of these energy-linked processes back to the late nineteenth century (Fix 2017: Figure 2, p. 5; see also the pooled cross-section/time-series charts in Figure 3, p. 6).

What drives this double-sided transformation? Why does the growth of energy capture per capita (depth) go hand in hand with the growth in the number and size of large capitalist firms and governmental organizations (breadth)? According to Fix, the answer is that the two processes are locked in an 'energy feedback loop' (our term): larger organizations are able to capture (and also tend to consume) more energy per capita than smaller ones (2015a: 26).

What makes larger organizations more effective energy converters – i.e., able to capture more energy per capita? In Fix's view, the main reason is that they are more *hierarchical*. Greater energy

[10] On the difficulties with Marshall's organization, see Wicksell (1935: Vol. 1, p. 107; quoted in Asimakopulos 1978: 370). On the problem of measuring Coase's transaction costs, see Buckley and Chapman (1997: 339-341) and Nitzan and Bichler (2009: 339-341).

[11] Fix refers to organizations, perhaps too broadly, as 'institutions'. The difference between the two concepts is important and we deal with it in Section 3.2.

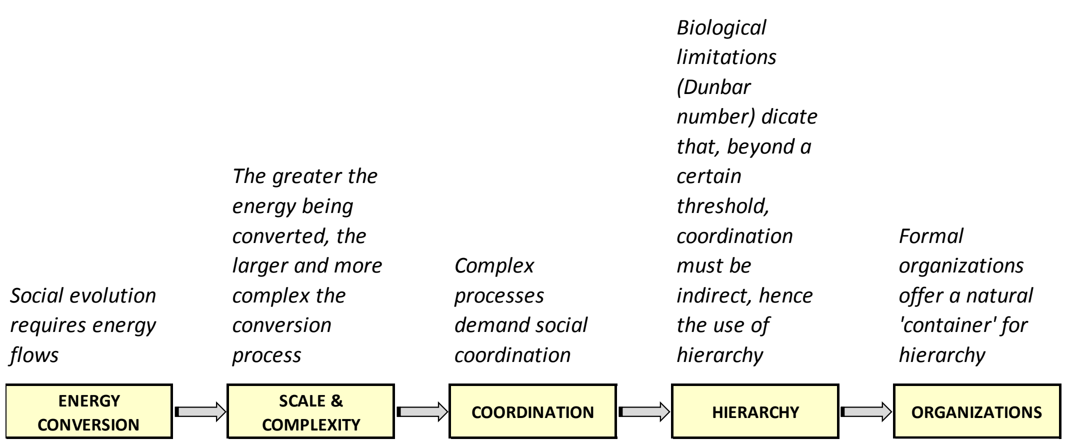
capture per capita, he posits, requires humans to coordinate their activities on an increasing and ever more complex scale. Biology, though, has made them ill-equipped for the job. According to Dunbar (1992), the relative size of their neo-cortex prevents them from maintaining more than 150 direct personal relationships, give or take ('Dunbar number'), and this restriction limits the *natural* size of human groups. In this sense, we can say that large-scale economic organizations – and therefore the 'economies of scale' they presumably give rise to – are rather *un*natural.

But society, Fix points out, can bypass this genetic limitation. As Turchin and Gavrilets (2009) explain, instead of relating to each other directly in a flat network, people can be forced to connect indirectly, via hierarchies. Now, unlike flat personal relationships, says Fix, hierarchical structures can maintain a large number of indirect connections without requiring any one individual to keep more than a few direct ties (in this case, with superiors and subordinates). And when the natural limit is so transcended, the size, scope and complexity of social organizations – and by extension, the depth and breadth of their energy capture – can be increased dramatically. In Fix's account, then, capitalist growth is not only *consistent* with the imposition of hierarchical power, it pretty much *requires* it.

To recap: according to Fix, social evolution, like all evolution, hinges on energy flows; the greater the energy being converted, the more complex the process of capturing it must be; complex processes necessitate social coordination, and the more complex they are the greater the coordination they require; human beings, though, are not hard-wired for this task, which is where social hierarchy comes into the picture: by linking people indirectly and impersonally, it enables coordination on a large scale.

Seen from this viewpoint, hierarchy is a necessary evil: a power institution that society must be shackled to in order to produce more energy. In this context, firms and governments can be viewed as 'the modern embodiment of social hierarchies', 'tools of social coordination' whose growth is akin to 'an investment in social hierarchy [. . .] necessary to mobilize increasing flows of energy' (2016: 14; 2017: 10). This argument is summarized in Figure 2.

Figure 2: From Energy Conversion to Hierarchical Organization



3.2 Organizations and Institutions

Now, if Fix is right, his research might turn out to be the opening salvo for a much bigger inquiry. The reason is that, while his theoretical argument refers to *institutions*, his empirical research focuses only on *formal organizations*, particularly corporations and governments, and this difference is more than semantic. 'Institution' is a loose term that denotes a set of practices, customs, relations and patterns. We might say that every formal organization is an institution, but not every institution is a formal organization. For example, the capitalist market, understood as a social totality, is an institution but not a formal organization – though actual markets are often organized by firms and governments. Similarly, systems of belief and thought, such as religion or science, are institutions but not formal organizations – although belief and thought can be fixed by formal organizations like a church or a state-run research and education system.

This distinction is important because institutions, just like organizations, can be highly hierarchical. Take the so-called capitalist market. In received theory, the market is a flat institution, comprising numerous buyers and sellers whose actions are independent of each other and whose size is too small to individually alter the overall outcome. In the actual world, however, the market is anything but flat. Judging by the level of income and asset inequality among households, the differential capitalization of firms and the complex ownership, business and regulatory ties between different groups and organizations, we can say that the actual market is always hierarchical.

And institutional hierarchy is by no means limited to the market proper. Recent advances in network science show that many *growing* associations – including those whose evolution is often thought of as spontaneous and voluntary, from the internet and World Wide Web, to aviation routes and NGO ties, to production chains, academic publications and terrorist organizations – end up developing into so-called scale-free networks. The term 'scale-free' here indicates that the *size* of the nodes, measured by the number of their connections, does not have 'typical' scale. Instead of following a bell-shaped distribution, it obeys power laws, with a small number of very large hubs dominating a countless mass of smaller nodes. So here too we have hierarchy.[12]

Now if seemingly loose associations can be just as hierarchical as formal organizations, Fix's thesis should be applicable, at least in principle, to the capitalist market and its related institutions *as well as* to formal organizations such as corporations and governments. And if we expand the vista in this way, the questions become much more involved. For instance, does the evolution of market and other institutional hierarchies complement or substitute for the development of organizational hierarchies? In other words, do the growth rates of formal and informal hierarchies move together or inversely? And, by extension, should we expect higher energy use per capita to be associated with an increase in *both* institutional and organizational hierarchy – or can this rise be associated with one *or* the other? To ignore these questions is to risk misattributing to organizational hierarchies effects that in fact emanate from broader institutional hierarchies, particularly since the scope of these latter hierarchies appears to have expanded significantly over time.

On a civilizational scale, the complex hierarchical linking of people, organizations and institutions in contemporary capitalism seems unprecedented. According to Taagepera (1997), over the past five millennia the effective number of distinct polities in the world has declined exponentially – dropping by two orders of magnitude based on population size, and by five orders of magnitude based on geographical area. Interestingly and significantly, the last two of the five orders of magnitude were shaved off in the past two centuries alone – i.e., during the capitalist epoch. This decline in the number of polities, compounded by accelerating population growth, has caused the absolute size of polities to increase exponentially, and as the polities have grown

[12] Barabási and Albert (1999). For an accessible history of network theory, and particularly scale-free networks, see Barabási and Bonabeau (2003) and Barabási (2014). On network hierarchies, see Faul (2016). A study of global corporate ownership networks is offered in Vitali, Glattfelder and Battison (2011).

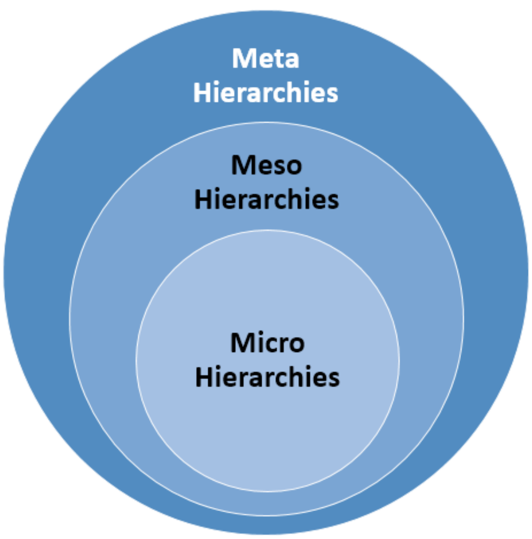
larger and larger, their internal structure has become progressively more hierarchical (Turchin and Gavrilets 2009).

Capitalism, we argue, has augmented this trend toward broader hierarchies in two important ways. First, the rapid spread of the price mechanism means that every new commodified relationship is automatically added to the expanding scale-free network of differential capitalization. Second, the globalization of trade, production and particularly ownership, along with the expansion of transnational organizations and institutions, enables hierarchies to easily 'jump' political borders in ways that were previously possible only through the cumbersome venues of elite marriage, formal treaties or military conquest.

3.3 Full-Spectrum Hierarchy

From this viewpoint, the capitalist creorder can be conceived of as a *full-spectrum hierarchy*, an ever-changing enfoldment of vertical structures nested within other vertical structures. Ranking the different hierarchies of capitalism from the most abstract down to the most concrete, we can say that the more concrete hierarchies are regulated by – and in this sense enfolded in – the more abstract ones. A simplified illustration of this enfoldment is shown in Figure 3: the lowest level comprises micro hierarchies; the micro hierarchies are nested in meso hierarchies; and the meso hierarchies are themselves encompassed by the meta hierarchies.

Figure 3: The Full-Spectrum Hierarchy of the Capitalist Creorder



What do the different levels consist of? Begin with the most abstract, meta hierarchies. The hubs of these hierarchies comprise the foundational institutions of capitalism, including, among others, the notion of 'liberty' (the differential Latin *libertates* fused into a universal notion of freedom), the concept of 'private property' (the negative Latin *privatus* inverted into a positive notion of possession), the idea of 'investment' (the feudal power of *investiture* reincarnated as a productive act) and the ritual of 'capitalization' (the ancient Mesopotamian *caput*, or head, made into a fractal-like algorithm of power) (Nitzan and Bichler 2009: 26, 227-228; Part III). The nodes of the meta hierarchies are the broad facets of society – the various dimensions of culture, ethnicity, religion and nationalism, among other things. And the links that tie the hubs to the nodes are the conduits through which the former gradually, and with plenty of setbacks and reversals, mould, leverage, internalize and encompass the latter.[13] At the meso level, the hubs are capitalist polities, corporations and NGOs, the nodes are individual subjects and the links are the capitalist institutions, patterns of thought and modes of behaviour that weave them into shifting hierarchies. And it is only at the lower, micro level of this full-spectrum enfoldment that we find the *inner* structures of organizations examined by Fix.

So if Fix is right in arguing that greater energy capture per capita requires more hierarchical coordination, we can go even further: we can hypothesize that, as the capitalist mode of power deepens and globalizes, a significant – and perhaps growing – proportion of this hierarchical coordination will occur *outside* the boundaries of formal organizations. It will take place not only at the intestinal micro hierarchies of corporations and governments, but also – and increasingly so – at the meso and meta levels of scale-free networks: the hubs and nodes here are the foundational institutions of capitalism, the broad cultural and political facets of societies and their basic organizational units, while the connecting edges are trade, production and ownership ties, the various media of ideology, religion and education, the law and, ultimately, the threat of force and violence.

3.4 Going the Other Way

Now, up utill now, our story has focused on production and energy: the driving force of society, we have claimed, following Fix, is to capture or convert more energy; more energy requires broader and more complex coordination; and the most effective way to achieve such coordination is through hierarchy. In short, in order to understand hierarchy we need to 'follow the energy'.

But this directive – although consistent with the facts – does not really address the basic question of our article. It explains how power can emerge from a *growth-driven society*, whereas CasP seeks to decipher the opposite link – namely, how growth can arise from a *power-driven society*.

Recall our starting point. Historical systems, we have argued, are best analysed not as modes of production and consumption, but as modes of power. And this claim is not based on a whim. The primacy of organized power goes all the way back to the beginning of written history, if not earlier: it has prehistoric lineages (Price and Feinman 2010); it is amply evident in the first city-states and empires of the Near East (Frankfort *et al.* 1946); it reappears, independently, in every early civilization (Trigger 2003); and it has continued to dominate the organization of society, at almost every level, ever since. Modes of power, we posit, rely on strategic sabotage, so it is hardly surprising that most of them have been relatively stationary and experienced only limited growth in energy capture per capita (Figure 1 and Table 1). The exception to this rule is capitalism, which, compared to previous modes of power, is highly dynamic and grows rapidly. From our viewpoint, therefore, the question is not why capitalism needs power *in order* to grow – simply because, in our opinion, capitalism, like other modes of power, is not driven by growth in the first place. The interesting question, rather, is why capitalism, although propelled by power, ends up growing *despite* the strategic sabotage that this power requires and entails. Given these considerations,

[13] Think of how the fractal-like sprawl of concepts such as 'financial accounting', 'investment' and 'capitalization' penetrate and permeate all levels of business – from the small grocery store, family firm and largest conglomerate, to mutual, pension and sovereign wealthy funds, to patents and copyrights – as well as other social institutions and organization, such as the military (the capitalized 'quantity' of the military arsenal and the 'return on military assets'), organized religion ('Islamic finance' and 'faith-based funds'), NGOs ('cultural' and 'social capital'), workers ('human capital') and so on (Nitzan and Bichler 2009: Ch. 9).

then, is it possible that, instead of hierarchy propelling growth, it is actually growth that boosts hierarchy?

4. Power for the Sake of Power

4.1. The Mega-Machine

Begin with Lewis Mumford. His book *Technics and Human Development*: *The Myth of the Machine* (1967) offers a novel interpretation of the early rise of power civilizations – or states – in the Fertile Crescent. The rulers of these ancient states, he argues, discovered the eternal cosmos and began to unlock some of its secrets, and this breakthrough has had far-reaching dialectical consequences. On the one hand, it enabled those rulers to leverage energy in ways that were previously unimaginable, while on the other, it showed them that, compared to the vast cosmos, they themselves were utterly insignificant. The result was a massive cognitive dissonance – an acute tension between infinity and nothingness, creation and termination, omnipotence and mortality – and according to Mumford, this dissonance subjected those early civilizations to a totally new obsession: *power for the sake of power*.

To manifest their newly found prowess while alleviating their fear of death, the rulers of these societies started to play god. And they did so, says Mumford, by constructing a social 'mega-machine', a highly mechanized hierarchical structure that sought to mirror their own cosmos and make them – the mega-machine's overlords – appear omnipotent and immortal.

The visible footprints of this mega-machine were phenomenal by prehistoric standards. The subjects of the mega-machine were forced to toil in the fields, dig canals, build complex irrigation systems and large granaries, construct huge palaces, temples and megalomaniacal graves and, last but not least, become cogs in large standing armies. Moreover, their endeavours mobilized energy at levels that earlier Palaeolithic and Neolithic societies could not even fathom. But according to Mumford, these were all means to an end. The ultimate goal was not to capture energy or transform the physical environment, but to make the mega-machine rulers feel almighty, divine and, above all, eternal.

This power impulse, we argue, continues to permeate all so-called civilized societies, including capitalism.[14] Indeed, on this count capitalism has only upped the ante. Over the past two centuries, it has given rise to a new mega-machine whose social and energy scales surpass those of all of its predecessors combined (Nitzan and Bichler 2009: Ch. 13). And here too, we maintain, the ultimate driving force is not faster energy conversion or a higher 'standard of living' – although both are important by-products – but the augmentation of power as such.

To augment capitalized power means to overcome resistance. It requires dispersed populations to be physically or virtually concentrated and institutionally locked into a controlled social grid – and that transformation is rarely if ever driven from below. Peasants do not volunteer to become urban masses, and urban masses do not rush to become nodes in capitalist hierarchies. They have to be expelled and lured, tempted and conditioned, threatened and forced. Moreover, once instituted, the imposition of organized power tends to become self-perpetuating. On the one hand, those who impose power cannot stop doing so: gripped by a Gilgameshian fear of death, they are compelled to pursue power at all costs; and haunted by the Hobbesian threat of counter-power, they cannot relent, even for a fleeting moment – for if they do, they quickly fall prey to

[14] Mumford's *The Pentagon of Power* (1970) extended his mega-machine theory to the modern state, but not to capitalism more broadly.

other power-hungry rulers who do not. On the other hand, those on whom power is imposed tend to resist it – though their resistance is usually internal to the power struggle itself. In most cases, their resistance fails, and even when it succeeds the end result usually is not the abolition of power, but a new form of power. It seems that once power-for-the-sake-of-power gets a hold of society, it becomes self-propelling, difficult to stop and nearly impossible to eliminate.

4.2 The Hierarchy of Evil

Seen from this viewpoint, the ultimate role of hierarchy is to augment not efficiency or the capture of energy more broadly, but power itself. One of the first modern thinkers to understand this role was Estienne de La Boétie, a contemporary of Niccolò Machiavelli. His tract on the subject, titled *The Politics of Obedience* (1975), was published in 1552-53, a bit after Machiavelli's *The Prince* (1532), but the two works could not have been more different. In fact, their respective purposes were totally opposite: whereas Machiavelli's offered a universal how-to guide for the power-hungry ruler, de La Boétie's focused on undoing tyranny and domination in the first place.

Contrary to received opinion, says de La Boétie, tyrannical power does not rest on open force, at least not directly:

> Whoever thinks that halberds, sentries, the placing of the watch, serve to protect and shield tyrants is, in my judgment, completely mistaken. These are used, it seems to me, more for ceremony and a show of force than for any reliance placed in them. [. . .] It is not the troops on horseback, it is not the companies afoot, it is not arms that defend the tyrant. (de La Boétie 1975: 71)

The real bulwark of tyranny is the 'hierarchy of evil' (our term):

> This does not seem credible on first thought, but it is nevertheless true that there are only four or five who maintain the dictator, four or five who keep the country in bondage to him. [. . .] These six manage their chief so successfully that he comes to be held accountable not only for his own misdeeds but even for theirs. The six have six hundred who profit under them, and with the six hundred they do what they have accomplished with their tyrant. The six hundred maintain under them six thousand, whom they promote in rank, upon whom they confer the government of provinces or the direction of finances, in order that they may serve as instruments of avarice and cruelty, executing orders at the proper time and working such havoc all around that they could not last except under the shadow of the six hundred, nor be exempt from law and punishment except through their influence. The consequence of all this is fatal indeed. And whoever is pleased to unwind the skein will observe that not the six thousand but a hundred thousand, and even millions, cling to the tyrant by this cord to which they are tied (de La Boétie 1975: 71-72).

4.3 Hierarchy as a Modular Information Field

To borrow David Bohm's quantum theory metaphor, we can think of de La Boétie's hierarchy of evil as an 'information field' (Bohm 1980; Bohm and Peat 1987). Topologically, hierarchy constitutes a symbolic order that serves to define, enfold and direct a concrete structure of societal institutions, organizations and people. This symbolic order allows rulers – from ancient emperors and liberal prime ministers, through capitalist owners and top executives, to army officers, religious leaders and organized-crime lords – to control the actual structure with minimal energy of their own. Like Master Blaster in Mad Max's *Beyond Thunderdome* – the brainy dwarf riding the shoulders of the mentally handicapped giant – they exert power not directly, but remotely: they use the symbolic topology as an Archimedean lever of concrete power, dispatching 'smart' low-energy information signals to unleash and direct the 'dumb' high energy of the social structure as a whole.

One of the most important power traits of hierarchy is that it can be made highly modular and therefore easy to discipline and quick to reconfigure. The following description of the Mongol army of the thirteenth century, taken from Malcolm Bosse's *The Warlord* (1983), depicts the superiority of a standardized, fully automated war machine:

> For one thing we can't even comprehend their discipline. They were formed into precise units [. . .]. There were ten thousand troops to a *touman*; that was their army corps. In the *touman* there were ten regiments of one thousand each, ten squadrons of one hundred each, ten troops of ten men each. Exactly. [. . .] No more or less. They were kept at full strength. If they had too many men, they waited in the rear – too few, they broke up the *touman* and set it to the rear also. In other words, to maintain their order, they'd risk going into battle with fewer men. [. . .] They must have been magnificent coming across the plain. [. . .] Approaching the enemy, the rear ranks advanced through the front ones and shot their arrows, retiring then to let the front ranks go to work. Fire and shock tactics [. . .]. When a superior force charged them – and they were usually outnumbered – they retreated by signal, regrouped by signal, turned and fired from a distance. Their tactics prevented wholesale slaughter of their own troops. They were never trapped, never annihilated, although sometimes outnumbered ten, fifteen to one. They never failed to execute any of their own who showed a moment of hesitation. They never spared the enemy, but killed their prisoners, cutting off the ears and sending them home to the Great Khan like tribute from kings. They were the greatest warriors of all time. (1983: 517-518)

This example serves to distil the two-way relationship between energy and hierarchical power. On the one hand, armies are pure power organizations. Their purpose is not to create, but to destroy, so the energy captured by their particular structure is a means of exerting power, by definition. On the other hand, since all armies are structured hierarchically, and since the role of armies is to destroy other armies, there is good reason to conclude that hierarchy offers the most effective way of converting and exerting energy for violent ends – for if it did not, hierarchical armies would have been defeated and replaced by flatter ones.[15]

Or would they?

[15] The emphasis on the destructive nature of hierarchy dates back to the early European bourgs, when the budding bourgeoisie portrayed its seemingly 'flat' market as a constructive alternative to the havoc wrecked by vertical feudal structures. Although contemporary capitalism can scarcely be described as flat and constructive (if it ever was), its antiquated self-portrait as a benevolent system continues to define the collective consciousness.

5. Cooperation

5.1. Anabasis

An interesting counterexample is offered by Xenophon's *Anabasis*, or *The March of the Ten Thousand* (1901; for a detailed analysis, see Lee 2007). *Anabasis*, which means an expedition from the coastline to the interior, is a tale of a military campaign gone wrong. Written by one of its participants, it narrates the historical journey of a Greek mercenary army, retained at the end of the fifth century BCE by a claimant to the Persian throne keen to unseat his brother. The expedition itself failed miserably, with the aspiring claimant and his entire military command slain and their ten thousand 'special forces' left stranded deep in hostile Persian territory. And that's when the story got interesting.

Surrounded by a far larger army, deprived of provisions and with no commanders to tell them what to do, the ten thousand seemed pretty much doomed. And yet, miraculously, they managed to beat the odds. They embarked on a long retreat, fighting their way back to Greece, which they eventually reached with relatively limited causalities.

How did they pull it off? Obviously, it wasn't their energy capture that saved the day: given that their breadth of energy capture (number of soldiers) was roughly 100 times smaller than that of the Persians, and since their depth of energy capture (energy per capita) was more or less the same, their overall energy capture was most likely two orders of magnitude smaller. The key, rather, was the way in which they put their energy to use.

Based on Xenophon's account, their success could be attributed, at least in part, to the manner in which they reorganized their army, contemplated their retreat and executed their plans. Their novelty was to introduce a second organizational dimension. While the Persian military was structured as a one-dimensional hierarchy of submissive cogs, the Greek mercenaries developed a two-dimensional modus operandi. When in combat, they acted hierarchically. But when they strategized, they did so as a 'marching democracy [. . .] deliberating and acting, fighting and voting; an epitome of Athens set adrift in the center of Asia' (from Carleton Brownson's 1922 introduction to his translation of *Anabasis*, quoted in Lee 2007: 9).

The democratic impulse came from the soldiers themselves. Although tainted by the lure of loot, they still carried, however loosely, the ethos of Greece's *demos-kratia* – the idea that society should be ruled *directly* by its own members. This democratic ethos conditioned them to assume personal responsibility and cooperate as autonomous beings, which made them not only far better soldiers individually, but also a more effective fighting force than the imperial mercenary- and slave-based armies around them.

Modern interpreters have often minimized the extent of this democratic moment. But even if limited, its very presence must have had a critical impact. The challenge for the retreating ten thousands was not only the overwhelming force of their opponent, the hostility of the local population and the difficult terrain, but also the genuine uncertainty of what might lie ahead. Consequently, they needed to continuously creorder their warpath. They had to look forward, ponder alternatives and weigh the odds. They had to invent new military tactics and come up with innovative logistic solutions. And last but not least, they had to constantly motivate and propel themselves, lest they sink into despair.

A hierarchical mega-machine of obedient soldiers cannot operate in this way. Its size and discipline allows it to deal powerful blows, and if modularly structured like Genghis Khan's army, it can also be quickly realigned for added flexibility. But the built-in subservience of its components makes it unable to creorder its *own* logic – and that is the key here. This inability might not be much of a handicap under relatively predicable circumstances. But when the conditions change radically and unpredictably, creativity becomes essential, and it is here that the Greek mercenaries had a clear differential advantage: socialized in the cultural context of a self-reflecting autonomy, they were able to operate democratically as well as hierarchically (electing their own officers, among other things); the combination of these two dimensions in turn allowed them to fuse the creative potential of autonomous cooperation with the decisive force of hierarchical command; and this fusion enabled them to use their energy much more effectively than their far larger yet more rigid hierarchical opponent.

Now, admittedly, this is only one counterexample.[16] But it is worth telling because it illustrates a general principle: autonomous cooperation is inherently more flexible than hierarchical command. As demonstrated by *Anabasis*, autonomously organized groups can resort to hierarchy if they deem it necessary to do so, but hierarchical groups cannot suddenly become autonomous.[17] And if autonomous cooperation can boost the effectiveness of even the most destructive of all human undertakings, what might it do to *constructive* organizations and institutions?

5.2 From Power to Cooperation

Liberal political economy, particularly its neoclassical dogma, loves to deride both hierarchy and cooperation: the former is seen as a remnant of the *ancien régime*, the latter as a socialist menace, and both as immoral, unjust and, in the final analysis, inefficient. A much better – in fact, the best – regulatory mechanism, argue the liberals, is a Hobbesian economic war of all against all (perfect competition). In this cruel cosmos, courtesy of Malthus, Darwin and Spenser, the fit survive and the unfit perish. And since to be fit in this world means to be productive and efficient, the never-ending economic combat, mediated by the invisible hand (supply and demand), ascertains the best of all possible worlds (an upward-spiralling Pareto-Optimal equilibrium).

As noted in Section 2, this official fundamentalism started to soften at the turn of twentieth century, when Alfred Marshall and Ronald Coase used 'organization' and 'transaction costs' to bring both hierarchy and cooperation into the neoclassical fold. And there was good reason for this softening. The global crisis of capitalism, together with the rise of communism and fascism, coincided with a broader contestation of the Cartesian-Newtonian worldview. Pitted against the competitive, bottom-up mechanical cosmos, there emerged a more 'biological' approach with

[16] The tale of *Anabasis* indeed seems unique. Consider for example the famous 8th Guards 'Panfilov' Rifle Division, which, similarly to the ten thousand Greeks, found itself under siege during the 1942 Battle of Moscow. Its story, immortalized in Bek and Baurdzhan's *Volokolamsk Highway* (1969, originally published in Russian in 1944), glorified the unbroken spirit of the 'popular' Soviet army and was later used as a template for organizing leftist guerrillas, freedom fighters and revolutionary undergrounds around the world. But the similarity with *Anabasis* is superficial at best. Leaving aside the fact that much of the book's plot was cynically fabricated by Stalin's propaganda machine, the picture it portrays has nothing to do with democracy and autonomy. Panfilov's was a highly hierarchical army reigned by fear and terror. The invigilating *politruks* terrified the commanding officers, who in turn threatened and penalized their rabble soldiers. Small violations were severely punished and executions were common. This modus operandi has little in common with that of the retreating Greek mercenaries. If anything, it resembles the German withdrawal from Russia as narrated by Remarque's *A Time to Live and a Time to Die* (1954), or the modern feudal-like Russian army described by Babchenko's *One Soldier's War in Chechnya* (2008).

[17] Technically, if we denote all possible forms of command-based organizations as set c and all forms of autonomous organizations as set a, we can say that c can be made a subset of a ($c \subset a$). For our purpose in the remainder of the paper, though, we treat the two sets as mutually exclusive.

lineages to the mythopoeic worldview of the ancient Near East and the organicist perspective of the Greek philosophers.

The contestations came from many different quarters: quantum mechanics shifted attention from distinct objects to mere connections, thus questioning the meaning of 'objectivity' and the separation of the observed from the observer; Gestalt psychoanalysis focused on the totalizing, irreducible nature of perception; and biology began to explore the concept of the biosphere, contemplating our ability to understand the living world and its environment not only from the bottom up, but also from the top down, as a complex system whose so-called 'emergent' properties transcend the sum of its components (for an overview and synthesis of these developments, see Capra 1996).

One common result of this contestation was a growing emphasis on the cooperative underpinnings of living systems. In literature, novelists like Roman Gary in *The Roots of Heaven* (1958) and Frank Herbert in *Dune* (1965) pointed to the impact of humans on ecological transformations, while science fiction writers like Olaf Stapeldon contemplated the role of symbiosis in the future history of humanity (*Last and First Men* 1930) and in the evolution of consciousness more generally (*Star Maker* 1937). In the life sciences, biologists and chemists like Lynn Margulis and James Lovelock made cooperation and symbiosis the linchpin of not only the interaction of distinct species, but also evolution itself, including the emergence of totally new species (Margulis 1967; Margulis and Sagan 1997), and the overall regulation of the planet's ecology – the so-called Gaia Hypothesis (Lovelock 1972; Lovelock and Margulis 1974; Lovelock 2000). Even Darwin's theory was grudgingly adapted to take cooperation into account through the concept of 'inclusive fitness' (Hamilton 1964b, 1964a). The forces of competition, command and violence, argued the new students of cooperation, might help *keep or eliminate* things that already exist; but, on their own, they cannot *create* something new. Genesis, they contended, cannot be imposed solely by force and violence. It needs a 'voluntary' spark, and that spark, they posited, is most likely to be generated through cooperation and symbiosis (Margulis in Teresi 2011).

These considerations bear directly on the subject of this paper. To create order – or creorder – requires energy. But in and of itself, the mere capture of energy does not tell us much about the *effectiveness* of its conversion (its ability to create order), let alone the specific *patterns* it gives rise to (the nature of the resulting order). For these, we need to understand what physicist-philosopher David Bohm calls the *generative order* – in this case, the specific 'algorithm' that directs the use of energy. And this algorithm, it seems to us, depends crucially on the ways in which power and conflict interact with cooperation and symbiosis.

6. Parochial Altruism

6.1 The Birth of Human Societies

The importance of this interaction for the evolution of prehistoric societies is examined by Choi, Bowles and Gintis in their sociobiological agent-based modelling of 'parochial altruism' (Choi and Bowles 2007; Bowles and Gintis 2011). Human beings, they point out, tend to be *both* altruistic (willing to benefit fellow group members at a cost to themselves) and parochial (hostile toward individuals not of their own group). At first sight, this duality might seem puzzling, since, on their own, neither altruism nor parochialism offers the positive payoff necessary for survival.

But if we consider the two traits not separately but *jointly*, argue Choi, Bowles and Gintis, the puzzle disappears.

The unique hallmark of parochial-altruist societies is that they *both* fuel war and benefit from its consequences: their outward bellicosity incites violent conflicts, while their inner cooperation helps them come out on top and reap the gains from those conflicts. Other sociobiological types – specifically tolerant altruists, parochial nonaltruists and tolerant nonaltruists – either do not incite violence or cannot benefit from it, or both. But parochial altruists can and do – and under specific genetic/societal/environmental conditions, say Choi and Bowles and Gintis, this difference can become evolutionarily crucial.

Using various game-theoretical simulations, they show that in situations where (1) most altruistic individuals are also parochial and vice versa, (2) most parochial altruists live in groups dominated by parochial altruists and (3) the physical environment is harsh enough to imply a struggle over resources, parochial altruism displaces other modes of social organization to become the norm. Such conditions, they then speculate, might have existed during the late Pleistocene and early Holocene (7,000 years ago, or earlier) – and if that speculation is correct, it might explain how the spread of war boosted altruism and vice versa, and why human societies have become disposed toward both conflict and cooperation.

6.2. The Rise of Complex Hierarchical Societies

This insight is carried further by cliodynamists Anderson, Gavrilets and Turchin, who argue that parochial altruism might account for not only the *co-emergence* of social power and cooperation, but also the *transition* from prehistoric societies, which were small and simple, to historic societies, which are large and complex (Turchin and Gavrilets 2009; Gavrilets, Anderson, and Turchin 2010; Turchin 2016). Since parochialism increases the group benefit from conquest while altruism makes such conquest possible, parochial altruism, they argue, has made human society war-prone. And since war boosts internal group cohesion, catalyses technological and organizational innovations, and enables bigger societies to trump and take over smaller ones, the result has been to make societies bigger and bigger.

On its own, though, this explanation is still insufficient. Larger societies, observe Anderson, Gavrilets and Turchin, are far more difficult to manage than smaller ones, so in order to continue and grow, they have had to change in two important respects. First, they have had to legitimize large-scale violence against other societies, which they have done by introducing broader *symbolic markers* to differentiate 'us' from 'them' (primarily by substituting religion, ethnicity, race and nationalism for the narrower markers of family and tribe). Second, they have had to facilitate inward coordination, which they have done by creating *complex hierarchies* – a social technology largely unknown to their prehistoric predecessors.

6.3 The Mix and Orientation of Cooperation and Conflict

All in all, then, parochial altruism offers an economic-biological theory of social evolution in which both the specific *mix* and respective *orientation* of cooperation and conflict change radically over time, and where both changes are closely connected to the conversion of energy. An advocate of this theory might summarize its evolutionary implications as follows.

In prehistoric societies, that advocate would argue, intergroup violence, measured in per capita casualties, was far more lethal than in historic societies (for ample evidence on this point, see

Pinker 2011; Diamond 2012; Gómez *et al.* 2016). But since prehistoric societies had limited food surpluses, their outward violence – however deadly – could consume no more than a small fraction of their time and effort. By necessity, most of their energy had to be devoted to inward, life-sustaining cooperation. In other words, in these early societies, the exercise of power and violence must have been mostly external and limited (in term of its energy requirements), while cooperation was mostly internal and paramount.

The emergence of food surpluses, which according to many mark the beginning of history, the theory's advocate would continue, altered this equation. Societies – or rather their *rulers* – were now able to devote a sizeable and often increasing portion of their energy to war-making, and that ability changed both the intra- and inter-societal dynamics. First, food surpluses allowed the amount of energy devoted to power and violence to rise relative to that dedicated to cooperation. Second, with more violent energy, the societal unit could begin to grow by conquering and taking over other social units. And third, the growth of the social unit – from families and tribes to chieftainships and eventually states – meant that power (and, if necessary, also violence) could now be projected not only outward, but also inward, through complex hierarchies, multiple threats and the organized use of physical force. So unlike in prehistoric societies, in historic societies, power – and the threat of violence that backs it up – is exercised not only externally, but also internally, and its claim on energy grows in importance relative to that of cooperation.[18]

6.4 The Spoils of War

With this understanding in mind, let us examine the framework of parochial altruism a bit more closely. As we see it, the evolutionary argument here rests crucially on the 'spoils of war': it is the

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[18] This stylized summary – and here we come back to our own perspective – merits an important qualification. As stated here, the parochial-altruism thesis seems to imply that food surpluses inevitably lead to a hierarchical society. In practice, though, that has *rarely* been the case. Many small prehistoric societies enjoyed transitory surpluses and some developed agricultural techniques that could have allowed such surpluses to be produced regularly. Yet in most cases, these surpluses were never produced, simply abandoned or ritualistically destroyed. And why? Because in those societies food surpluses had no perceptible use and, if allowed to exist, would have threatened the very egalitarian underpinning of their culture (Mandel 1962: Vol. 1, Ch. 1).

It seems that the systematic production of food surpluses took hold only in those societies where a rudimentary power hierarchy *already existed* (or had been imposed from the outside). Simple irrigation techniques, for example, were known outside of and prior to the rise of the delta civilizations, but with no one to impose them, they were seldom used to cultivate crops (Frankfort 1951: Ch. 2). According to Jared Diamond (1999: 23), 'detailed archaeological studies have shown that complex irrigation systems did not accompany the rise of centralized bureaucracies, but *followed* after a considerable lag. That is, political centralization *arose for some other reason* and then permitted construction of complex irrigation systems' (emphasis added). In the Near East, the rise of large-scale irrigation went hand in hand with the imposition of new crops, particularly wheat and barley. Unlike the diverse range of Neolithic plants that often require intense cultivation on small, independent plots, wheat and barley are highly suited for large-scale hierarchical production: they are easy to standardize, relatively high in yield, fairly resilient and easy to store. That, in any event, is what we see in the first palatial hierarchies of the Fertile Crescent, where delta-irrigated wheat and barley made it possible for rulers to concentrate and control large multitudes of property-less peasants and slaves, build imperial armies, organize hierarchical religions, erect complex bureaucracies and develop exclusionary writing and arithmetic.

All in all, then, we can argue that, in and of itself, surplus food – and rising energy capture per capita more generally – is a *necessary but insufficient* condition for hierarchical society. For such a society to emerge, the power drive must be there to begin with. This power drive has to enforce not only the very creation of surplus food and energy, but also its particular production techniques and specific end uses. Without this enforcement, the surplus would either not be produced at all or be directed for non-hierarchical ends.

spoils of war that supposedly explain the pre-historic co-emergence of social power and cooperation, and it is the spoils of war that presumably account for the historic rise of large and complex hierarchical polities. But, then, *who* exactly gets these spoils, and what do the spoils *consist* of?

Begin with the appropriators. In prehistoric societies, the triumphant group would normally take over or usurp the natural and social resources of the losing one, and given that prehistoric societies tended to be relatively flat, these resources would probably be distributed *relatively equally*. But in historic societies, the endgame can be very different. Since most if not all historic societies are hierarchical and therefore inherently unequal, the loot and tribute of war, both immediately and over the longer term, are likely to be spread rather *unevenly*.

And indeed, as far as historic societies are concerned, that is what the indirect data seem to suggest, particularly for early polities. According to Milanovic, Lindert and Williamson (2011), preindustrial societies with low per capita income (below $800 per annum in 1990 purchasing power parity) tended to push against what the authors call the 'inequality possibility frontier', meaning that the vast majority of their population was kept at or close to physical subsistence, leaving the remainder of the social produce (and war booty when available) to be appropriated mostly by their elites.[19] These results suggest that, unlike in flat prehistoric societies, the underlying populations of early hierarchical societies *had relatively little or nothing to gain – and perhaps plenty to lose – from initiating war* (defensive war is obviously different). And if that was indeed the case, it implies that the initial foray of small flat societies into violent hierarchical expansion must have been forced on the majority by a small minority (see footnote 18).

The second, related question concerns the underlying motivation for war: do societies really fight over material 'spoils' – and if so, why? In prehistoric societies, the answer, again, seems obvious: under harsh environmental conditions, war booty could have spelt the difference between life and death, so fighting over it must have offered a significant evolutionary advantage. The situation in historic societies, though, is radically different. Since these societies produce surplus food and therefore do not face the threat of biological annihilation, and given that most of their population stands to gain little and perhaps lose plenty from hostile expansionism, the drive for war must come primarily from their rulers. But then – and here we come to the crucial point – for the rulers, whether they acknowledge it or not, the spoils of war are almost always a means to an end rather than the end itself. Their ultimate purpose in going to war, we argue, is not the biological survival of society, let alone the rulers' own, but the *aggrandizement and expansion of their power for its own sake.*

6.5. From Agents to Structure: Dematerializing Parochial Altruism

In our view, one of the key limitations of the parochial-altruism model – and of evolutionary game-theoretical modelling more generally – is the twin emphasis on *individual actors* and *material gain* (on the assumptions and implicatons of evolutionary game theory, see for example Varoufakis 2008; Adami, Schossau, and Hintze 2016). Note that these models are commonly

[19] In the ancient empires such as Akkad and Rome, the underlying population of the imperial core seemed to have enjoyed a higher 'standard of living' than those of the periphery. This differential, though, can be very misleading, if only because most of the core's population ended up there after losing its allodial lands to the imperial elites through confiscation and appropriation. In this context, the Roman 'bread and circuses' offered by the *Cura Annonae* (free grain supply) and various forms of entertainment were hardly the spoils of victory. If anything, they were the means of controlling and placating a disgruntled and volatile population, dispossessed, uprooted and proletarianized by the endless demands of imperial expansion (for a rich literary account of these processes, see McCullough 1990).

referred to as 'agent-based'. Although often applied to pre-capitalist societies, their starting point is the basic atom of the liberal cosmos – the independent human agent. Propelled by their inner preferences and inclinations, these atoms are assumed to interact with each other spontaneously. Mediated through Newton's attraction and repulsion reincarnated as Smith's demand and supply, they truck and barter, cooperate and fight, procreate, kill and die; and it is these seemingly free-willed interactions, the model posits, that gradually weave the pattern of social evolution, giving rise to an emergent societal structure. The specific goals of the atoms can vary greatly, depending on the particular model, and they can be innate or acquired. But subservient to the Malthusian-Darwinian logic of the liberal world, they are all geared to serving one ultimate purpose: *survival*. And since survival requires energy, the social atoms are completely obsessed with 'material payoff'. All they want is 'stuff' – things that either contain or can generate the energy they need to survive – and the rest is noise.[20]

As we have already seen, though, when we move from prehistoric to historic societies – i.e., to polities that already generate surplus energy and whose biological survival as such is no longer at stake – the individualist-material rationale for conflict, violence and war becomes too restrictive and possibly misleading. But, then, since historic polities, just like their prehistoric predecessors, tend to be both externally bellicose and internally cooperative, it must be that somewhere along the line their parochial altruism was partly if not largely *dematerialized*.

What are the theoretical implications of a dematerialized parochial-altruistic society? For one, we can no longer refer to its modelling as *agent*-based. And why not? Because to say that a model is based on agents is to imply that there is nothing *prior* to those agents: that they are the starting point, the source of all preferences, and therefore the prime mover of everything else. This, of course, is the liberal worldview. And as long as the agents' autonomy is restricted to material payoff, their actions are by and large predictable and the model is normally soluble. However, when agents are no longer bounded by physical survival, their unbounded autonomy makes them unpredictable, and an agent-based system of unpredictable agents cannot be modelled, by definition.

Historically, this dilemma presented liberal modellers with two options: stick to the liberal ideal of autonomous atoms and rethink the way they should be modelled – or protect the existing model by sacrificing the very liberal ideal on which it rests. And judging by the current status of liberal modelling, most if not all have opted for the latter option: Aldus Huxley's free-thinking 'savages' and 'Alpha Double-Plus' clones were ceremonially discharged, replaced by pre-programmed 'Deltas' and 'Epsilons' who stick to the plot and do precisely what their modellers tell them to (Huxley 1932; Nitzan and Bichler 2002: 146).

Now, ideology aside, there is little reason to contest this analytical arrest. After all, all living creatures, including liberal humanoids, are conditioned by their natural and social environment, so the notion that they are somehow wholly or even largely autonomous was always a bit of a stretch. But then – and here we come to the key point – if the modellers accept that humans are partly or largely predetermined, they should also recognize that their modelling is no longer agent-based, but *structure*-based.

Unfortunately, though, this recognition per se does not get the modellers off the hook. Not by a long shot. The problem is that, although action is now said to be dictated by the structure of

[20] Evolutionary game theory often defines payoff more broadly as 'evolutionary fitness'. But since evolutionary fitness means the ability to survive and procreate, and given that this ability hinges on the capture and conversion of energy, in the end the payoff must be 'materialized'.

the model rather than the free will of its agents, that action is no longer motivated solely by physical survival. As noted, some of it – and often much of it – is driven by *power for the sake of power*, and this new emphasis can make the model unstable, indeterminate and even insoluble.

In the economic-biological approach, agents are conditioned to maximize their material gain, *subject* to the 'rules of the game' (which, as far as the agents are concerned, are fixed or at least independent of their own actions). In a world driven by power, however, that is no longer the case. Here, the acting units – be they human beings, formal organizations or looser institutions – are propelled, at least in part, to *alter the rules themselves*. They are conditioned not only to increase their material payoff within a given structure, but also – and often primarily – to creorder that very structure. And if the main driving force is to creorder society, the game-theoretical framework – whether we call it actor- or structure-based – breaks down. Instead of operating in a Newtonian universe whose particles are contained in a prefixed space with a given set of rules, we find ourselves in a Leibnitzian cosmos whose particles are driven to bend and creorder the very logic of the space they constitute (Nitzan and Bichler 2009: cf. 279-282).[21]

6.6 Taking Stock and Looking Ahead

To recap, our argument thus far has been that, although power hierarchies are pursued for their own sake, social organization can never be entirely hierarchical. It always involves – and must involve – some autonomous cooperation. Indeed, it is perhaps not far-fetched to suggest that this duality – i.e., the quest for power and the necessity of cooperation – lies at the very root of social evolution. The problem, though, is that the cutting-edge models that seek to explain this process – particularly those based of parochial altruism – are too restrictive. They might help explain social evolution when power is mostly a means to material ends, but they become unstable and possibly insoluble when power is sought for its own sake.

And as we shall see below, the difficulty goes even deeper. First, power for the sake of power tends to undermine autonomous cooperation, particularly on a large scale and certainly as a guiding principle. As a consequence, autonomously cooperative organizations are few and far between, which means that there is no meaningful benchmark against which to assess the relative ability of hierarchy to capture and convert energy and therefore the claim that hierarchical institutions emerge and persist *because* of their superior energy capture. Second, hierarchical societies use a significant portion of their energy merely to erect and maintain their hierarchies, which in turn means that much of their headline growth is dedicated not to wellbeing, but to augmenting and defending power *as such*. Sections 7 and 8 address these issues in turn.

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[21] Hargreaves-Heap and Varoufakis (2004: 234) consider the first step in this quantum leap, namely the possibility that changes in structure might alter action: '[I]magine a model in which preferences and beliefs (moral and otherwise) are simultaneous by-products of some social process rooted in the development of organised production [. . .]. These theoretical moves will threaten to dissolve the distinction between action and structure which lies at the heart of the game theoretical depiction of social life because it will mean that the structure begins to supply reasons for action and not just constraints upon action'. This depiction, though, stops short of what, in our view, is the ultimate trap: a model whose actors are not only *affected* by its evolving structure, but are *driven to actively alter it*.

7. Are Hierarchies Better at Capturing Energy?

7.1 Subjugating Energy to Power

If hierarchy were merely a means of capturing/converting energy, its ubiquity might lead one to believe it must be the most effective way of doing so. But if hierarchical power is not – or at least not principally – a means to an end but the end itself, energy capture becomes a subsidiary goal, if at all. And if that is indeed the case, the link between hierarchy and the conversion of energy becomes more complicated and difficult to assess.

To illustrate, assume that the goal of power overrides that of energy capture in only a few polities or in a small number of organizations within those polities. In this case, the relatively low energy capture of these polities/organizations might make them easy prey to other, less dogmatic and therefore more effective energy capturers, and this relative inferiority could in turn cause them to be defeated, be taken over and disappear. But if power for the sake of power is universal across and within *all* polities – meaning that energy capture is by and large subservient to the inherent quest for power – then there *is no longer a necessity for polities and organizations to capture as much energy as they can*. In this context, power-driven entities are akin to the scorpion who asks the frog to carry it over a pond, stings its carrier halfway through and then defends its self-defeating act by saying 'It's in my nature'. Just like the scorpion, power-driven entities simply 'cannot help it': they *have* to pursue power for its own sake even if that pursuit causes their energy capture to linger. And if *all* entities are conditioned in this way, the net result is for their entire differential pecking order to downshift to a lower average level of energy capture.

This outcome is not as farfetched as it may sound. One of the basic premises of strategic sabotage is the idea that, in order to impose power, one has to *undermine* societal efficiency, and although societal efficiency is not the same as energy capture, the underlying rationale is not very different and useful to consider. According to the path-breaking work of Stephen Marglin (1974), rulers have consistently and routinely undermined the efficiency of their subjects: when the Romans rammed slaves into brick and pottery 'factories', when European feudal lords imposed water mills and prohibited hand mills, when post-bellum American planters forced a credit-based system of sharecropping on small farmers and when Stalin collectivized Soviet agriculture – the purpose, argues Marglin, was to make their subjects easier to rule, even at the cost of lower efficiency. And the same argument holds for the emergence of capitalist production: British capitalists, says Marglin, retained demonstrably inefficient mining techniques, introduced the factory system well before the arrival of machines and insisted on a minute division of labour that was debilitating to the point of becoming technically counterproductive, particularly in comparison to the efficient labour cooperatives they sought to dismantle (Nitzan and Bichler 2009: 233). Finally and discouragingly, as the long menu of sabotage-fuelled differential returns in Section 2.1 clearly demonstrates, things haven't changed much since then.

Societal efficiency and energy capture need not go hand in hand (the growth of waste, for example, can lower the former while raising the latter). But the very existence of societal inefficiencies, particularly if they are built into the logic of power, suggests that society's capacity to capture/convert energy is rarely if ever put to full use. Now, since power in capitalism is gauged not by the differential capture of energy, but by differential profit and capitalization, and given that differential profit and capitalization hinge on various forms of strategic sabotage, we end up with a hierarchical order of entities whose relative power is conditioned, at least in part, on their differential ability to *incapacitate*.

The problem with this claim, though, is that, in capitalism, much of this under-capacity utilization – whether measured in output or energy – does not show up in the official statistics. And why not? Because capitalist measures of capacity utilization – which typically fluctuate between 70 and 90 per cent – are benchmarked not against some *absolute* maximum, but relative to the (much lower) level that capitalists consider *optimal in terms of profit*. Thorstein Veblen, one of the first writers to point out this built-in discrepancy, claimed that if we were to compare output not to the capitalist maximum, but to the 'technological' one, utilization rates would stand at 25 per cent (1919: 81). Indeed, in some sectors, such as military production, this rate has been recently estimated at a mere 10 per cent (U.S. Congress 1991: 38).

7.2 Telling Examples

So why not abandon the artificially low capitalist measures and instead estimate the *actual* capacity capped by available technology? The reason is that, when it comes to society as a whole, this actual capacity might be unknowable. Since the ability of a society to capture energy depends on the way it is organized, the only way to determine its maximum capture rate (read 'capacity') is to rank energy capture levels across the entire spectrum of possible organizational types – from the most hierarchical forms of command to the most autonomous forms cooperation – and use the highest capture rate as our benchmark. This comparison, though, is difficult if not impossible to conduct, particularly on a large enough scale. And why? Because when institutions and polities are driven by power for the sake of power, they tend to systematically discourage, prevent and disable cooperative initiatives – especially if they are autonomous, doubly so if they are big, and most definitely so if they are successful.[22] And since this systematic exclusion makes flat cooperative organizations and polities few and far between and truly autonomous ones non-existent, we end up with no basis for comparison.[23]

But there are still telling examples. Drawing on Knorr-Cetina (1999), Ulf Martin (2016: 39) brings up the case of CERN, the European Organization for Nuclear Research. CERN operates the world's largest particle physics laboratory – one of the most powerful energy converters ever created. Its complexity is mindboggling: it constitutes a collaboration of numerous states; its facilities are used by hundreds of institutions; it has over 13,000 people on site; and its staff is comprised of thousands of scientists and over 10,000 visiting experts. And, yet, despite its record energy capture and high complexity, the CERN organization is remarkably flat. The participating scientists are often top experts in their field, so there is little room for 'command' to begin with (who could tell them what to do?). Moreover, their very activity – from theorizing, to experiment design, to implementation and conclusions – is inherently cooperative, so even the impulse to

[22] Witness the fate of the U.S. Tennessee Valley Authority (TVA). Founded during Roosevelt's 'First One Hundred Days' in 1933, the TVA operated in seven states to provide electric power, flood control and water conservation, as well as to rebuild eroded soil and produce fertilizers. The initiative was highly efficient, both technically and economically, and boasted a huge energy capture – its energy output per capita was twice the U.S. average, and it was produced at half the national cost. The problem, though, was that the TVA was highly democratic and involved extensive grassroots autonomy. The demonstrated effectiveness of this flat model of cooperative planning threatened the underpinnings of private capitalized power, and that threat pretty much ascertained that the United States would never engage in a similar experiment again (Baran and Sweezy 1966: 165-167).

[23] We should note here that the problem concerns not only the *measurement* of efficiency and capacity, but also their very *definitions* (see footnote 7). Autonomous communities, attuned to the wellbeing of their members, are likely to conceive of these notions very differently and perhaps inversely from the way they are perceived in contemporary capitalist states, whose yardsticks are geared not toward the livelihood of their subjects, but toward the power interests of their rulers (Nitzan and Bichler 2009: 225-226).

command is weak (many CERN papers are co-published by everyone involved, which often makes the list of contributors longer than the articles themselves . . .).

Now, on the face of it, the ability to coordinate highly complex large-scale operations through flat, voluntary cooperation might seem to contradict the limits imposed by Dunbar's number (Section 3.1). In human societies, though, this limit might be less firm than in animal ones. First, even if the biological cap on personal connections means that, beyond a certain scale, the size of human society can grow only by connecting groups rather than individuals, the connections between those groups need not be *hierarchical*. Second, although humans, like other animals, might be incapable of personally interacting with more than a limited number of their peers, unlike other animals (or so we think), there is practically no limit to their *impersonal* interaction. Their open-ended imagination, symbolic systems, record keeping and long-range (and nowadays instant) communication make it possible for them to form associations and collectives whose scope is no longer restricted by the size of their neocortex.

In his novels *The Elementary Particles* (2000) and *The Possibility of an Island* (2005), Michel Houellebecq conceives a hologramic alternative to the discrete materialism of human biology. Inspired by Alain Aspect's 1982 experiment in which distant subatomic particles were shown to be 'inseparable', he envisages a future in which human beings are genetically engineered to be entangled with rather than separate from each other. But, then, is this capacity to be entangled with rather than bounce off each other not here *already*? As Ulf Martin points out, given that the most technically complex activities such as CERN's can be coordinated with limited hierarchy and in a relatively power-free way, why can the very same thing not be done with technically simpler and far less complicated tasks?

Hierarchies, then, are not necessarily the most effective way to convert energy. Although the evidence here is by no means ample, the little that does exist suggests that, when allowed to operate autonomously, flat coordination can be equally if not more effectual. This tentative conclusion, thought, brings us right back to where we started: if hierarchies are not built in order to bolster the capture of energy in the first place, and if they are not necessarily the most effective way of doing so anyway, why does energy capture per capita correlate with hierarchical structures?

8. Energy for Hierarchy

To answer this question, we need to examine the *purpose* for which the energy is used. From a bio-physical perspective, that purpose is irrelevant. Once 'captured', a joule of energy is just like any other, regardless of the work it ends up doing or how much of it dissipates as waste. But if we are to decipher the connection between energy capture and social hierarchy, the purpose of energy is crucial, particularly in hierarchical societies. And why? Because in hierarchical societies a good chunk of the captured energy is earmarked not for material gain, livelihood and wellbeing, but for *sustaining and fortifying the hierarchical structure itself*. Moreover, and as we shall see below, the split between the portions going to hierarchy and livelihood is *never* fixed. In fact, it is *bound to vary*, both across societies and over time, and this variability means that, in practice, there is no one-to-one mapping between the overall energy capture of society and the 'livelihood' of its population: for any given level of energy capture, there can be a whole range of 'standards of living'.

These observations have important implications, to which we return in Section 9. Before doing so, though, we need to ask *why*? Why does the build-up and maintenance of power hierarchies require energy in the first place? The short answer, which we unzip below, is that power hierarchies elicit resistance that has to be contained and generate complexities that need to be maintained, and this 'containing and maintaining' requires plenty of energy.

8.1 Resistance

As noted, a mode of power is a social order driven by power for the sake of power. The quest for power, though, is deeply dialectical: it implies its own negation and therefore can exist only against opposition and resistance. This resistance, we argue, takes two forms: power-*replacing* and power-*negating*. The first form is internal to the power struggle itself, and it arises because attempts by one entity to impose power are almost always opposed by other entities that strive to impose this very power. In capitalism, for example, governments, corporations, labour unions, religious apparatuses, criminal networks and other such organizations constantly contest each other's power, and this ongoing contestation means that power always faces resistance. The same principle, though with different contenders, applies to other modes of power – from ancient city-states and empires, to feudalism, oriental despotism and state communism.

The second type of resistance is external to the power struggle proper. It originates not from a quest for power, but from its very negation – namely, the desire to undo hierarchy altogether in favour of autonomy and cooperation. This latter drive is often latent, buried under the dead weight of hierarchical power, but it is always there – for if it were not, there would be nothing to rule over and no need for power to start with.

Power is imposed mostly through organizational and institutional hierarchies, and since the quest for power is ever present, so is the drive to create and extend its hierarchies. Now, since hierarchical power is constantly opposed and resisted from within and without, its imposition requires ongoing strategic sabotage: new contenders to power are always lurking and need be eliminated or at least undermined and contained, while those who are to be dominated have to be persuaded, tempted and forced into submission. And these activities – and here we come to the key point – *consume a significant portion of society's energy*. They imply standing armies, organized religion, a legal system, various bureaucracies, police forces, ongoing propaganda and other such dedicated institutions, as well as numerous dual-purpose activities that physically sustain society as well as maintain and augment its hierarchical order.

8.2 Complexity

Moreover, and importantly, the build-up of power hierarchies tends to feed on itself in an 'autocatalytic sprawl' (Martin 2016). The stronger the imposed power and its associated sabotage, the greater the resistance to it, and therefore the greater the need to contain and overcome that resistance with even more hierarchies and additional sabotage. The net result of this autocatalytic sprawl is to make power-driven societies appear increasingly 'complex'.

Most students of complexity, though, do not accept this derivation. Following the biological-economic perspective, they tend to think about social 'complexity' positively rather than negatively, as an inevitable aspect of social scale as such. Tainter (1988, 2000), for instance, suggests that the larger the society and the greater its use of energy, the harder it is to coordinate; that the greater the coordination problems, the more difficult and involved their solutions; and that while the solutions may provide local, short-term fixes, over the longer run they tend to make society even more complex, thus creating further problems in need of new solutions and therefore even greater complexity.

In our opinion, though, this positive reasoning can be highly misleading. It seems to us that part – and possibly a significant part – of the complexity of power-driven societies stems not from trying to boost efficiency, but from trying to control it – and if need be, undermine it – for power ends. And if our hypothesis here is correct – and at this point it is admittedly just a hypothesis – then social complexity should be examined less as a 'problem-solving strategy', as Tainter calls it, and more as a built-in lever of sabotage, a negative feature *inherent* in any self-propagating mode of power.

Most power-driven complexities, we propose, are unintended, emerging from the confluence of otherwise separate forms of strategic sabotage. Take the early twentieth-century destruction of urban public transportation in the United States, undertaken by the country's major oil and automobile companies (Barnet 1980: Ch. 2). On its own, this destruction represented a run-of-the-mill attempt by a corporate coalition to augment its differential profit through strategic sabotage. We can say the very same thing about numerous other attempts, including the substitution of the internal-combustion engine for electric cars, the subsidized construction of the highway system and the mortgaging of middle-class Americans into debt servitude. Each of these processes was promoted by and served the power interests of a particular alliance of corporations and investors. For our purpose here, though, the interesting thing to note is their *combined* consequence – which, in this case, was the emergence of a highly complex suburban sprawl whose ecological destructiveness goes hand in hand with its massive energy capture. Nobody masterminded this destructive energy sprawl – and there was no need to. When various acts of sabotage converge, particularly on a large enough scale, the growth of energy-sucking complexity is all but inevitable.

Or consider the growing global centralization and politicization of the food, medical and leisure sectors. Over the past half-century, the intersection of these processes culminated in the imposition of a cheap junk-food diet, massive overmedication and the progressive sedation of the population through passive entertainment and physical inaction (Bichler and Nitzan 2016a). The net result of these otherwise separate forms of strategic sabotage is a worldwide epidemic of obesity, diabetes, heart disease and mental illness – which has in turn given rise to a sprawling, energy-guzzling complex of social, health and legal hierarchies, all dedicated to . . . 'solving the problem'. Here too, the resulting complexity has been largely unintended, but given that this complexity originated and continues to be perpetrated in support of hierarchical power, most of the energy it absorbs ends up going not to livelihood and wellbeing, but to strategic sabotage, by definition.

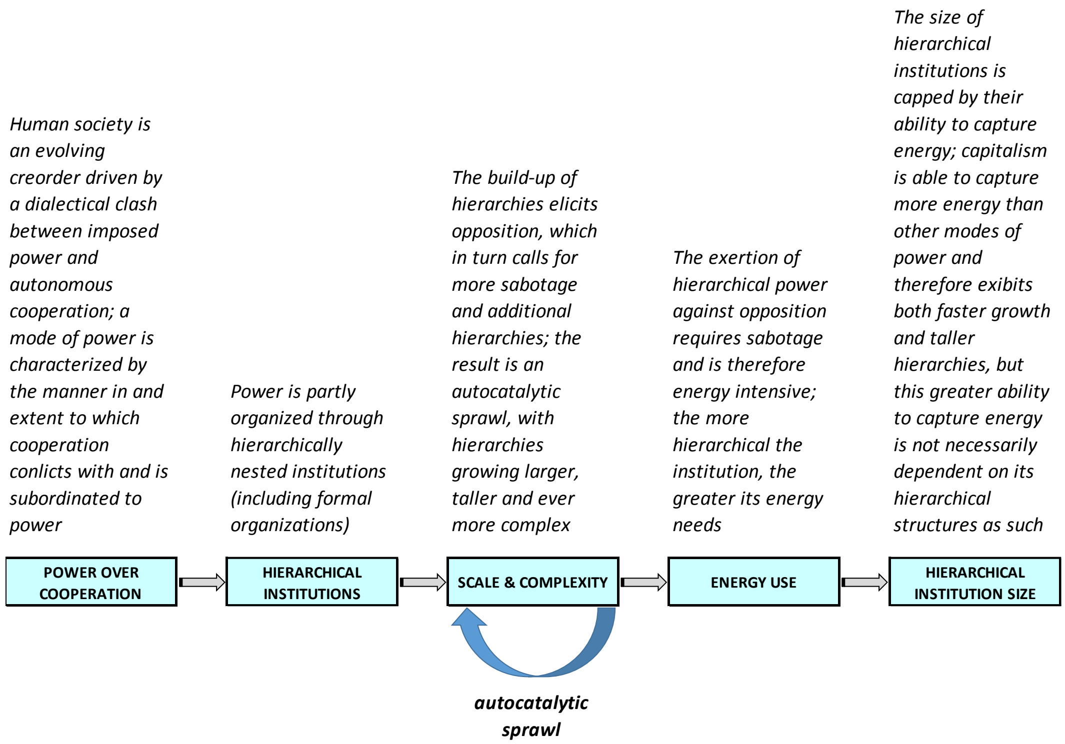
Finally, while most power-driven complexity is probably unintended, some of it is clearly premeditated. Much of the barrier-laden design of computer hardware and communication networks, for example, is deliberately complex – as are the Kafkaesque aspects of the legal system and the intricate and often impenetrable maze of modern accounting and finance. The energy captured by this intentional complexity adds little to wellbeing and livelihood and plenty to hierarchical power.

9. Toward an Alternative Model

9.1 Overview

With most of the pieces now in place, we can begin to model, however tentatively, the relationship between energy and hierarchy, the ways in which this relationship might evolve in different modes of power and the implication of this evolution for the capitalist mode of power more specifically. The following five points, outlined visually in Figure 4, highlight the basic premises on which we build our model.

Figure 4: From Hierarchical Organizations to Energy Capture



1. Human society is an evolving creorder driven by a dialectical clash between imposed power and autonomous cooperation. A mode of power is characterized by the manner and extent to which autonomous cooperation conflicts with and is subordinated to power.

2. Power relations are partly organized through the imposition of hierarchically nested institutions and organizations.

3. The imposition of hierarchies elicits opposition and therefore requires strategic sabotage, which in turn calls for the exertion of more power through greater sabotage and additional hierarchies. The result of this process is an autocatalytic sprawl, with hierarchies becoming more numerous, taller and increasingly complex.

4. Since the exertion of hierarchical power against opposition necessitates strategic sabotage, and because sabotage requires energy to be carried out, hierarchical structures, regardless of their specific purpose, consume energy. Everything else being the same, the more hierarchical the institution or organization, the greater the energy needed simply to erect and sustain it. Consequently, the size and height of hierarchical institutions are capped by their ability to capture energy.

5. One thing that differentiates capitalism from other modes of power is its ability to capture much more energy and therefore create far larger and taller hierarchies, hence the correlation between overall energy capture per capita and hierarchy. The pace of this process, though, is not necessarily dependent on hierarchies being more effective energy capturers than other modes of coordination.

9.2 Hierarchical Energy, Livelihood Energy

Our starting point in modelling the relationship between energy conversion and hierarchy formation is to split the total energy captured/converted by society into two distinct flows: (1) *hierarchical energy* that serves to impose, sustain and augment hierarchical power, and (2) *livelihood energy* that provides for subsistence and wellbeing. Now, while the total level of captured energy might be objectively given (at least in principle), its bifurcation into 'hierarchical' and 'livelihood' flows is not. As it turns out, this division is bound to be coloured by our political, ideological and theoretical disposition, and that bias is sure to affect the way we analyse and measure the two flows. So before turning to the actual model, it is important to examine this split more closely and put it in some context.

To see the difficulty, consider the energy spent on standing armies, organized religion, the legal system, various bureaucracies, police forces, the management of propaganda and the various forms of oppressive, suppressive and violent material technologies. On the face of it, these institutions and organizations seem pretty much dedicated to supporting hierarchy – but are they? Is all of that energy indeed earmarked for that purpose, or only part of it? And if only part of the energy goes to hierarchy, how do we know the proportion? And that is just for starters. In principle, we can say that *every* institution and organization serves hierarchical power to *some extent*, which, analytically, means that part of the energy it consumes – ranging anywhere from 0 to 100 per cent of the total – goes to that end. But how do we quantify this portion? Or take the energy consumed by social complexity as such. What part of this energy should be traced back to the strategic sabotage that made society more complex in the first place, and what part is in fact necessary for providing subsistence and wellbeing? And if these questions are not difficult enough, consider this one: what do we do when a given flow of energy serves *both* hierarchy and livelihood at the same time? How do we decide what part goes to what end?

These questions are by no means unique to our specific bifurcation here. Although usually swept under the empirical carpet, they plague many of the basic divisions in political economy – including, among others, the distinctions between 'productive' and 'unproductive' labour, 'speculation' and 'investment', 'waste' and 'useful' output, and 'utility' and 'disutility', as well the attribution of specific outputs to specific inputs in so-called joint production processes (Nitzan and Bichler 2009: Chs. 5-8).

In fact, the problem is hardly limited to political economy as such. It pops up in any attempt to order the world, particularly when the ordering requires that we assign a 'cause', identify 'force', or attribute 'determination' (Bunge 1961, 1979). Note that in order to distinguish livelihood from hierarchical energy, we must first figure out what *causes* energy capture to increase or decrease, what *forces* society to be more or less hierarchical and what *determines* the flow of energy to livelihood as opposed to hierarchy. And since the answers to these questions cannot be entirely objective, neither can the quantitative split they give rise to.

9.3 Quantifying Quality: An Interpolation

To order the world we must first categorize its qualities, and as the qualitative categories multiply, we soon find ourselves trying to quantify them. This quantification of qualities is always Protagorean. It is mediated through our senses, emotions and consciousness – in other words, through our discretion – and this discretion means that the result can never be entirely objective (i.e., external to and independent of our perception and cognition). For the purpose of our model here, then, the key issue is not that qualities are being transformed into quantities and that this transformation cannot be universally given; we take this limitation as inherent. The interesting questions, rather, are, first, how this Protagorean transformation is made to look universal, who enforces this apparent universality and to what ends; and second, whether we can bypass this enforcement, however tentatively, to yield some general insights.

In early civilizations, the quantification of qualities was often associated with the *imposition of power* – including the ranking of deities, the measuring of wealth, the parcelling of land, the pricing of violence and the costing of protection, among other inflictions. One of the first written records of such quantification comes from a broken Sumerian clay tablet, written some four millennia ago. The tablet lists various offenses, assigning to each of them a specific pecuniary penalty:

> If a man has cut off with an . . . –instrument the foot of another man whose . . . ., he shall pay 10 shekels of silver. If a man has severed with a weapon the bones of another man whose . . . ., he shall pay 1 mina of silver. If a man has cut off with a *geshpu*-instrument, the nose of another man, he shall pay 2/3 of a mina of silver. (Kramer 1963: 84-85; missing parts in the original)

In giving acts of violence a price, the Sumerians effectively quantified their qualities, making them commensurate with every other priced violence – and, indeed, with *every priced quality* more generally. The early penal quantifiers probably sanctified their decrees to make them look heteronomous and hence unassailable, but in the end, they were their *own* arbitrary doing.[24] And this arbitrary aspect, we posit, remains present, however imperceptibly, in every quantification of qualities ever since.

Now, throughout much of history, the quantification of power was *imposed from above*, dictated, vetted, consecrated and regulated by the gods through their earthly representatives – the rulers. For nearly five thousand years, this was the only way in which historic societies engaged with the world around them. There was one exception, though: the Greek poleis. Unlike the then-dominant mythopoeic worldview in which subject and object were deeply intertwined and where worldly outcomes were often conjured up jointly by human agency and divine intervention, the Greek philosophers painted a stricter separation. They separated the physical world from both gods and humans, and what enabled them to conceive of and affect this separation was the radically different structure of their society.[25]

[24] The key role of heteronomy in the evolution of societies is developed in the writings of Cornelius Castoriadis.

[25] The emancipation of thought from myth and the associated separation of subject from object are explored in Frankfort and Groenewegen-Frankfort (1946). According to Kramer (1948), though, the mythopoeic thesis – and, by extension, the notion that the Greeks were the first to separate subject from object – is overstated and possibly wrong.

Whereas other civilizations were organized as power hierarchies, the Greeks creordered a *demos-kratia* – the first historic polity introspected, articulated and ruled directly by its own members – and this flat, self-organized society allowed its philosophers to envisage a cosmos independent of divine rulers and sanctified deities.[26] This independent cosmos emerged with Thales, who searched for the common denominator, the primordial substance that everything in the world is made of. It continued with Democritus, who argued that all matter – which our senses perceive as a kaleidoscope of different qualities – in fact comprises various rearrangement of the same set of eternal atoms. And it was further propelled by Pythagoras, who went on to portray the world as a quantitative totality in which everything relates to everything else as ratios of two integers, or rational numbers. For the Greeks, these quality-to-quantity conversions existed 'out there'. They depended neither on the will of the gods nor on the blessings of priests and kings. They were *universal*.

But it was only with the liberal-scientific revolution of the seventeenth and eighteenth centuries that the quantification of qualities was formally and thoroughly depoliticized – or so it seemed. Whereas the Greeks articulated the cosmos in the abstract, the new scientists went on to systematically *measure* it. Furthermore, they insisted on doing so recursively, quantifying nature in its 'own natural units', so to speak. Thus, the standard metre was defined as a fixed fraction of the planet's circumference, the kilogram anchored to a given volume of water, the second related to the sun's movement, the ampere benchmarked to Newton's gravitation force, the kelvin linked to the volume of mercury and so on. Moreover, categories as such were placed on a scale – ranging from the 'nominal', to the 'ordinal' to the 'cardinal' – giving the impression that shifting from one to the other was somehow a mere technicality. Even uncertainty and errors were given an objective shape, delineated by probability and statistics. Put together, these advances made the laws of the universe look eternal, liberated from the menace of political intervention, religious sorcery and plain human irrationality – or as Newton famously called it, 'the folly of men'.[27]

9.4 The Units of Political Economy

Political economists – the first scientists of society – were part and parcel of this process. On the one hand, the emergence of capitalism with its physical machines, mechanized social structures and rapidly spreading price system, offered 'natural philosophers' ample metaphors for conceiving of and visualizing the physical cosmos. On the other hand, the new scientists of society were all too eager to imitate the objective measures devised by physicists, chemists and biologists (Bichler and Nitzan 2012a). Spirited by these new winds of scientific progress, Jeremy Bentham, the first scientist of pleasure, created the elementary particle of liberalism – which he called 'felicity'

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[26] The role of human autonomy in the evolution of Greek philosophy and science is examined in Farrington (1969). The Greek *demos-kratia* is often criticized for excluding women, foreigners and slaves. This exclusion, though, was premised on the notion that the excluded were not part of the demos in the first place and therefore has no bearing on the *principle* of direct democracy as such. Indeed, considering the despotic context in which the Greek experiment emerged (think of Persia and Egypt circa 500 BCE), its democracy, although covering only part of the population, probably ranks as the most radical socio-conceptual revolution ever.

[27] Of course, invisible to most practicing scientists, Protagoras is still very much with them, hiding in their human-made mechanical apparatuses, crawling in the theories they use to translate and interpret the signals of those apparatuses and popping up in the occasional scientific revolution to help them objectively discard what they previously considered objectively given (as happened in the refutations of the luminiferous ether, the stationary universe, numerous atomic models, spontaneous generation, vitalism, caloric theory, etc.).

(later renamed 'util' by Irving Fisher). All human motivation, he argued, could be reduced to universal quantities of pleasure and pain, and this reduction, his fellow economists have since come to believe, allows us to denominate all economic activity in universal units of 'wellbeing' and then use these units to discover the self-equilibrating laws of liberal (read natural) society. Marx rejected this universalism. Historic societies in general and capitalism in particular, he claimed, are driven not by mutually beneficial interactions among individuals, but by the clash of conflicted classes. This conflictual setting – which in capitalism pits those who own the means of production against those who work them – requires a totally different elementary particle. And since, according to Marx, the root of the conflict lies in the sphere of production, the key unit of political economy should be based on labour – the 'socially necessary abstract labour time', or SNALT, that 'productive workers' must spend, on average, to produce a given bundle of commodities.

As we have shown in our own work, though, the problem with these supposedly objective measures is that they are not objective in the least (Nitzan 1989; Nitzan and Bichler 2009: Chs. 5-8). Simply put, utils and SNALT cannot be measured, even in principle. Moreover, the very idea that a conflictual society can be understood with a single universal measure is an invitation for trouble. We agree with Hegel and Marx that society develops dialectically, evolving out of its inner contradictions. But this dialectical evolution, by its very nature, involves *both* conflict and cooperation, and those two dimensions, we posit, cannot be expressed in a single language (Nitzan 1998: 196; Nitzan and Bichler 2009: 19-21; 220-221). While the underlying population experiences the world mostly through the *absolute* categories of livelihood, the rulers view it through the *differential* lens of power. And since the absolute and differential viewpoints are fundamentally different and often incommensurate, it is hard to see how they can be brought to a common denominator, let alone a quantitative one. To understand them, we need not one language, but two: a conflictual language for power and hierarchy, and a cooperative one for subsistence and livelihood.

9.5 Back to Energy and Hierarchy

As we shall see below, although energy flows to both livelihood and hierarchies, the effect it has on these two processes is so different that 'more livelihood' does not necessarily mean 'less hierarchy', and vice versa. Moreover, although the two flows originate from the same source, the split between them depends, at least in part, on whether we take the viewpoint of the rulers or the ruled. As noted, these indeterminacies haunt any and every quantification of qualities. The difference here, though, is that, unlike the liberal and Marxist quantifications, ours *explicitly* recognizes its own limitations and is therefore less likely – or so we hope – to fall prey to the 'reality principle' that Freud articulated and Marcuse so eloquently critiqued.

'In its refusal to accept as final the limitations imposed upon freedom and happiness by the reality principle', writes Marcuse, 'lies the critical function of phantasy' (1955: 149). 'Without phantasy', he posits, 'all philosophical knowledge remains in the grip of the present or the past and severed from the future, which is the only link between philosophy and the real history of mankind' (1968: 114). Following Marcuse's lead, we shall show that, although the quantification of livelihood and hierarchical energies is always arbitrary to some extent, this arbitrariness can be partly sidestepped. By using our imagination – or fantasy, as Marcuse calls it – we can draw the overall boundaries of the two energy flows, examine their possible historical trajectories and explain why the CasP puzzle of growth in the midst of sabotage is in fact no puzzle at all.

10. Hierarchy-Energy Space and Hierarchy-Energy Curves

Begin with a generic mode of power defined by the following concepts. Unless indicated otherwise, the remainder of the paper uses 'energy' as a shorthand for *energy capture*, as defined in Section 1.

GJ	gigajoule (1 billion joules)
E	total energy per capita = $HE + LE$ (GJ/year)
HE	hierarchical energy per capita (GJ/year)
LE	livelihood energy per capita (GJ/year)
H	share of hierarchical energy in total energy = HE/E (decimal)
hes	hierarchy-energy space containing all (H, E) combinations
hec	hierarchy-energy curve containing all (H, E) combinations for a given LE

The total annual energy per capita converted by this hypothetical mode of power is E. This total comprises two sub-flows: hierarchical energy per capita HE and livelihood energy per capita LE, such that $HE + LE = E$. The relative share of hierarchical energy in total energy is given by H.

Before putting these concepts to use, two clarifications are in order. First, as noted in Section 9, the particular division between hierarchical and livelihood energy is subjective to some extent, so the absolute magnitudes of HE and LE will depend on the viewpoint of the observer. Our analysis, though, is concerned not with absolute magnitudes, but with general trajectories, and as we shall later see, as long as the observers' viewpoints remain fixed, our results hold for all observers.

Second, our distinction between hierarchical energy per capita HE and livelihood energy per capita LE refers not to how the energy is produced, but to the manner in which it is consumed. Thus, both flows can be generated by hierarchical and/or flat organizations (or some combination of the two), and thermodynamically, both can be produced efficiently or inefficiently (relative to available knowledge). These differences do not matter for our distinction here. The only thing that counts is the *purpose* for which the energy is used: HE is used to impose hierarchical power, while LE is used to provide subsistence and wellbeing. Having said that, note that there is no presumption that the energy is efficiently utilized: as it stands, a given amount of hierarchical or livelihood energy can give rise to *various* levels of both hierarchy and livelihood, depending on the social effectiveness of its application.

With these clarifications in mind, the relationship between total energy per capita E and the fraction of hierarchical energy H is given by Equation 2:

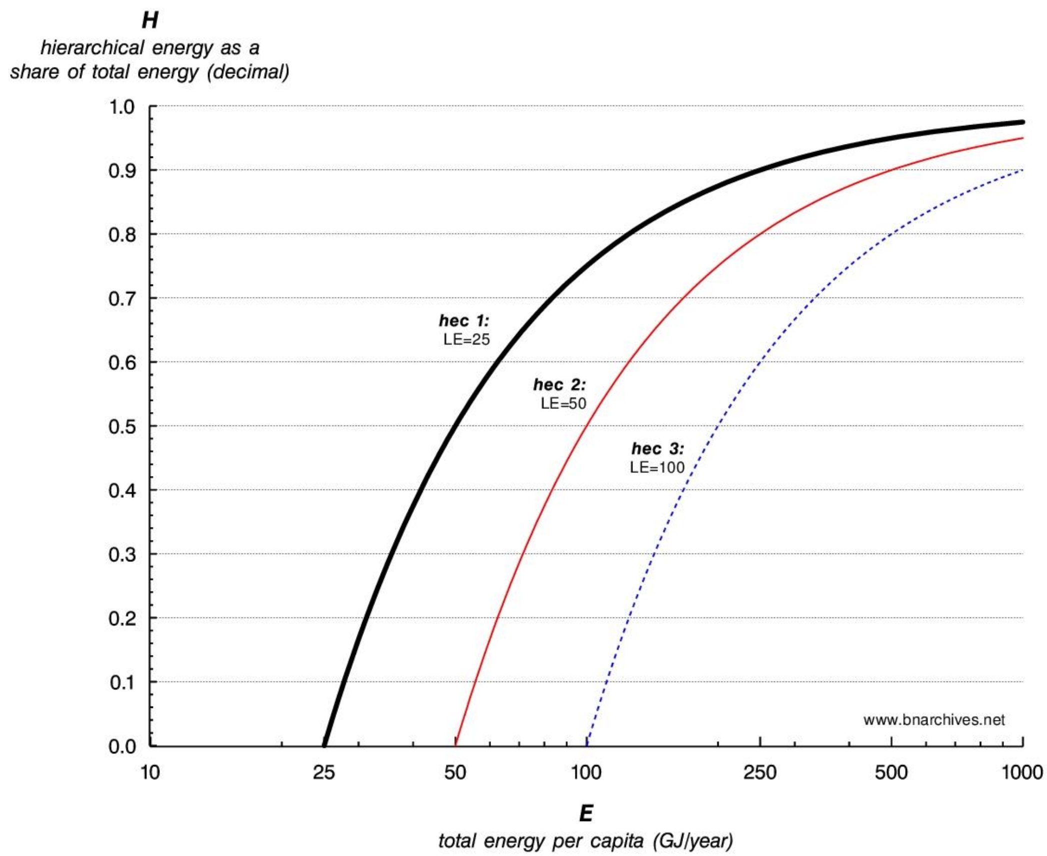
2. $H = \frac{E - LE}{E}$

Equations 2 is bounded, such that $0 \leq H < 1$. Graphically, the relationship between H and E traces what we call a *hierarchy-energy curve*, or *hec*, which is in turn plotted on a *hierarchy-energy space*, or *hes*. We call it a 'space' since it relates three variables: H, E and LE.

10.1 The Hierarchy-Energy Curve

Figure 5 shows the *hes* with three different *hecs*. The *hes* is bounded from three sides – bottom, left and top – and is open-ended on the right. The horizontal axis shows the size of E (the actual origin of the E-axis is 0; we use 10 here for presentation purposes). The vertical axis shows the magnitude of H. Each *hec* traces all possible (H, E) pairs for a given level of LE. To reiterate, the level of E is objectively given, while the split into LE and HE – and therefore the proportion H – are determined partly by the observer's particular viewpoint. In this section we take the static viewpoint of a given observer. As we shall see in Section 11, however, when we move from static positions (levels) to dynamic trajectories (rates of change), the same conclusions can be generalized to all observes.

Figure 5: Hierarchy-Energy Curves



Begin with the left-most *hec* (thick black line). This *hec* is associated with livelihood energy per capita $LE = 25$ GJ/year. When $LE = E$, the *hec* intersects the horizontal E-axis. At this intersection the entire energy of society goes to livelihood, leaving nothing for the imposition of hierarchy. At all other points on the *hec*, $LE < E$, meaning that some of society's energy goes to hierarchy. The farther to the right a point is on the *hec*, the greater the E. And since LE is assumed fixed throughout, as society moves up and to the right on the *hec*, an increasing share of its growing E goes toward the imposition of hierarchy, hence the rising H. Note, though, that since livelihood energy LE is positive, the fraction H can never reach 1; it can only approach it asymptotically at higher and higher levels of E.

The other two *hecs* describe (H, E) combinations for higher levels of livelihood energy: the thin red *hec* is for $LE = 50$ GJ/year, while the dashed blue *hec* is for $LE = 100$ GJ/year. Note that the higher the LE, the farther down and to the right the *hec*, and therefore the greater the level of both E and LE for any given level of H (rightward shift), the lesser the value of H and the greater the value of LE for a given level of E (downward shift), or some combination of the two (a shift down and to the right).

Finally, and importantly, note that (1) a *hec* cannot intersect the vertical H-axis at $E = 0$ (since that would imply a society that converts no energy yet sustains a hierarchy); (2) each (H, E) combination can lie on one and only one *hec*; and (3) different *hecs* can never touch or intersect.

Now notice that the *hes* speaks not one language, but two: *absolute* and *relative*. The absolute language quantifies the flows of energy E, LE and HE in GJ per person/year, while the relative language measures the share of hierarchical energy in total energy H as a decimal fraction. The underlying population is concerned mostly with the absolute magnitudes: all else remaining the same, the greater its LE, the better off it is. For the rulers, though, the absolute numbers are merely means to an end. Their goal is broader and taller hierarchies, and this goal, we posit, depends not on the absolute GJ magnitude of hierarchical energy HE, but on its relative share of the total H.

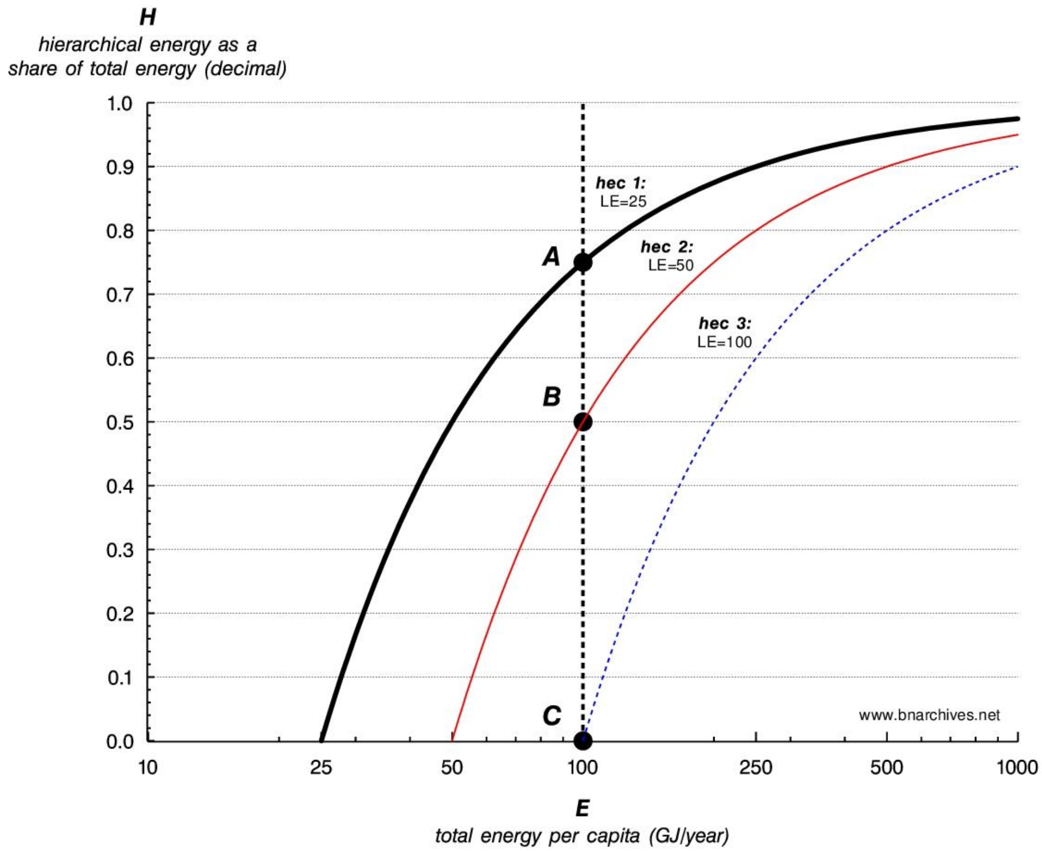
To illustrate the importance of this linguistic duality, consider Iceland and North Korea. Suppose Iceland has 70 GJ per person/year flowing into hierarchy, while North Korea has only 15. Seen through these absolute spectacles, Iceland devotes to hierarchy nearly five times more energy than North Korea. But when it comes to hierarchies, the yardstick is not absolute, but relative – and when we shift from totals to differentials, the picture in this particular case gets inverted. According to World Bank data, North Korea's total per capita energy is roughly 30 GJ per person/year, compared to Iceland's 700, which, given our assumption about their respective levels of HE, means that North Korea's H is 0.5 (= 15/30), or five times *bigger* than Iceland's 0.1 (= 70/700). So although North Korea's HE is far lower than Iceland's, its much higher H suggests that, all else being the same, it is likely to be the more hierarchical of the two.

10.2 Lost in Hierarchy-Energy Space?

As noted, while the horizontal axis of the *hes* is more or less objectively given, the vertical axis is not: it depends, at least in part, on the viewpoint of the observing analyst. Figure 6 illustrates the consequence of changing this viewpoint.

The chart augments Figure 5 with a vertical dotted line that intersects the horizontal axis at a total energy flow of $E = 100$ GJ per person/year. Now, suppose the society in question devotes no energy to hierarchy, so $HE = 0$. This situation is described by point C. And since every point in the *hes* can lie on one and only one *hec*, the relevant curve for this society is *hec 3*. In order for this society to move up and to the right on *hec 3*, the total flow of energy E must rise and the increase must be channelled entirely into hierarchy. Now, assume that, instead of devoting nothing to hierarchy, society splits its total 100 GJ per person/year in two, with 50 going to livelihood and 50 to hierarchy. This situation is represented by point B located on *hec 2*. To move up and to right on the curve, society has to increase its total energy flow E and channel all the additional energy into hierarchy, while to move down and to the left it has to produce less E and curtail the flow into hierarchy by that exact reduction. Finally, suppose that out of the total flow of 100 GJ per person/year, 25 go to livelihood and 75 to hierarchy. This situation is represented by point A on *hec 1* – and here too, a movement up and to the right on the *hec* requires a greater E with the addition going to hierarchy, while a move down and to the left on the curve implies a lower E and an equal curtailment of energy going to hierarchy. In other words, for every level of E, we can draw any number of *hecs*, each representing a different split between HE and LE.

Figure 6: Hierarchy-Energy Curves: Alternative Interpretations



Now, this vertical line with its intersecting *hecs* can be drawn for any given society at any given point in time. For instance, based on World Bank estimates, the vertical line for Iceland circa 2010 will cross the E-axis somewhere around 700 GJ per person year, the line for North Korea around 30 and the line for Afghanistan around 4. However, since we do not know the objective hierarchical/livelihood mix of these totals, we cannot determine the objective vertical location of each society. And since the mix might not be objectively given to start with, we can end up with different observers making different assessments. A libertarian anarchist, for example, seeing power everywhere, might argue that most of the energy of the society depicted in Figure 6 goes to building and supporting hierarchy and therefore judge its location as point A. By contrast, a member of the ruling class, convinced that most hierarchy is in fact necessary for well-being and therefore draws no energy away from livelihood, might insist the society in question is located close to point C. And a social democrat, taking the middle ground, might place it at point B.

But as we shall now see, these differences do not matter for our purpose here. Our main concern is not the *specific position* of society, but its *dynamic trajectory*. And as it turns out, the analysis of this trajectory – at least at the general level engaged with here – is independent of the particular hierarchy/livelihood mix and therefore applicable to any point on the *hes*, regardless of the observer.

11. Trajectories in Hierarchy-Energy Space

Figure 7 and Table 2 use the *hes*/*hec* framework to examine the full range of possible societal trajectories. We start from an arbitrary point Z. In our illustration, Z lies on a *hec* with $LE = 25$, at coordinates $H = 0.5$ and $E = 50$. Since Z is arbitrary, our analysis and conclusions hold for any other position on the *hes*.

Figure 7: Trajectories in Hierarchy-Energy Space

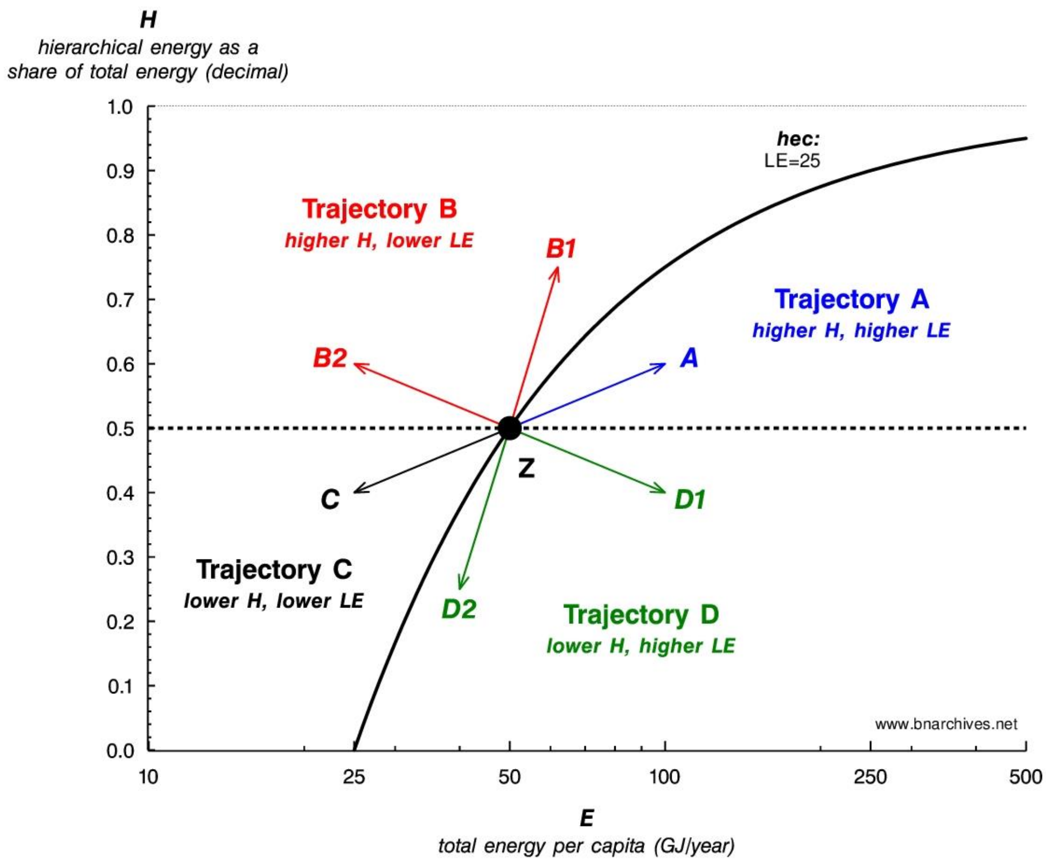


Table 2: Trajectories in Hierarchy-Energy Space

	Trajectory A	Trajectory B	Trajectory C	Trajectory D
Mode of power	expanding	in crisis	declining	democratizing
Hierarchical energy share H	rising	rising	falling	falling
Livelihood energy LE	rising	falling	falling	rising

Beginning from *Z*, society can move in four general directions, denoted in the figure by four groups of arrows. Each group, representing a distinct trajectory, is bounded on one side by the *hec* and on the other by the horizontal dashed line going through point Z. Movements along the *hec* or the horizontal dashed line are common to two adjacent trajectories and therefore constitute borderline cases. An arrow represents a movement of the mode of power to a different location on the *hes* and therefore a shift to a different *hec.*

Considered on a long-term time scale, each trajectory can be seen as representing a different phase in the evolution of a mode of power.[28] The trajectories/phases are classified based on two criteria: changes in the relative share of hierarchical energy H (represented by a movement up or down from point Z) and changes in the level of livelihood energy LE (visualized by a movement away from the *hec* to the right or to the left). Using up and down arrows to indicate an increase or decrease in the relevant variable, we label a mode of power *expanding* when ($H \uparrow LE \uparrow$), *in crisis* when ($H \uparrow LE \downarrow$), *in decline* when ($H \downarrow LE \downarrow$) and *democratizing* when ($H \downarrow LE \uparrow$). The technical aspects of each trajectory, summarized in Table 2, are explained in the numbered paragraphs below.

1. *Expanding (Trajectory A).* The movement here is up and to the right of the *hec*, which means that *both* the relative share of hierarchical energy H and the absolute flow of livelihood energy LE are rising. In this trajectory, more energy per capita E gets captured, and the addition flows to both livelihood LE and hierarchy HE. However, the increase in HE is faster than in E, so the relative share of hierarchical energy H ends up rising as well.

2. *In Crisis (Trajectory B).* The movement here is up and to the left of the *hec*, which means that the relative share of hierarchical energy H and the absolute flow of livelihood energy LE move in *opposite* directions: the former is rising while the latter is falling. This trajectory can follow two distinct paths: one in which the total flow of energy E is increasing and another in which it is decreasing. The first path, represented by *Trajectory B1*, points up and to the right (although still to the left of the *hec*). In this trajectory, both E and H are increasing, while LE is falling. The second path, represented by *Trajectory B2*, points up and to the left. Here, both E and LE are falling, while H is rising (with HE either rising absolutely or falling more slowly than E).

3. *In Decline (Trajectory C).* The movement here is down and farther to the left of the *hec*, which means that *both* the relative share of hierarchical energy H and the absolute level of livelihood energy LE are falling. This trajectory is an inversion of *Trajectory A.* Here, less energy per capita E is being generated, and the deduction reduces both livelihood energy LE and hierarchical energy HE. However, the decline in HE is faster than in E, so the relative share of hierarchical energy H is falling as well.

4. *Democratizing (Trajectory D).* The movement here is down and to the right of the *hec*, which means that the relative share of hierarchical energy H and the absolute flow of livelihood energy LE move in *opposite* directions: the former is falling while the latter is rising. This trajectory is a mirror image of *Trajectory B*. Here too there are two distinct paths – one in

[28] Trajectories could also be viewed from a shorter-term perspective, though we leave the analysis of such movements to future studies.

which the total flow of energy E is rising and another in which it is falling. The first path, represented by *Trajectory D1*, points down and to the right. In this trajectory, both E and LE are increasing, while H is falling. The second path, represented by *Trajectory D2*, points down and to the left (although still to the right of the *hec*). Here, both E and H are falling, while LE is rising.

Let us now look more closely at each trajectory in turn.

11.1 Growing Through Sabotage

We call *Trajectory A* an 'expanding mode of power' because the share of hierarchical energy H and the level of livelihood energy LE are *both* rising. This dual increase helps keep the mode of power in place: the rise in H sustains and augments the hierarchical structure, while the increase in LE, by catering to the underlying population, masks the growth of hierarchies, reduces resistance from below and limits the risk of systemic upheaval.

Trajectory A is historically new. As already noted, until a few hundred years ago, modes of power have experienced very little and often no increase in total energy per capita, let alone in livelihood energy per capita (Figure 1 and Table 1). The first and – as of today – only mode of power in which both H and LE have *risen on an ongoing basis* is capitalism (the second is state communism, though that regime faltered and disintegrated within a short historical moment).

Now, on its own, the observation that capitalism goes hand in hand with growing energy per capita is hardly breaking news. The interesting thing, rather, is that a substantial part of this growth flows – and indeed *must* flow – not into wellbeing, but into hierarchical power. This latter claim is crucial: if true, it means that when we measure capitalist growth, we measure, at least in part, the *growth of power itself*. In this sense, capitalism grows not despite or even because of sabotage, but *through* sabotage.

Figure 8 and Table 3 illustrate this point by comparing three *A*-type trajectories – *A1*, *A2* and *A3*. The trajectories share two things in common: first, they all represent the doubling of energy per capita E (from 50 to 100 GJ/year); and second, in all of them the change in both livelihood energy and the share of hierarchical energy is non-negative (so $\Delta LE/LE \geq 0\%$ and $\Delta H/H \geq 0\%$). *A1* and *A3* are borderline trajectories, delineating the limits of the possible in an expanding mode of power. *A1* represents the minimum rate of change of livelihood energy ($\Delta LE/LE = 0\%$) and the maximum change of the hierarchical share of energy (which, in this case, is $\Delta H/H = +50\%$), while *A3* marks the minimum rate of change of the hierarchical share of energy ($\Delta H/H = 0\%$) and the maximum rate of change of livelihood energy (in this case, $\Delta LE/LE = +100\%$).

Note that, with the exception of the borderline *Trajectory A3*, the hierarchical energy share H is always growing, which in turn means that the growth of livelihood energy *is always slower* than the growth of total energy (so $\Delta E/E > \Delta LE/LE$). This growth differential is important because, if the flow of livelihood energy correlates with wellbeing, it follows that, in an expanding mode of power such as capitalism, headline increases of total energy per capita are likely to *overstate* – and possibly by a wide margin – the growth of society's welfare.

Note also that the faster the growth rate of total energy per capita $\Delta E/E$ (i.e., the more the arrow extends to the right), the higher the maximum growth rate of the hierarchical share of energy $\Delta H/H$ (i.e., the more the trajectory can be 'pulled up' toward the *hec*). This relationship is important because, if higher per capita energy ends up steepening the trajectory so as to channel a greater portion of the energy into hierarchy, then this tendency might offer an alternative explanation for why energy per capita correlates positively with hierarchy.

Figure 8: Three Trajectories in an Expanding Mode of Power

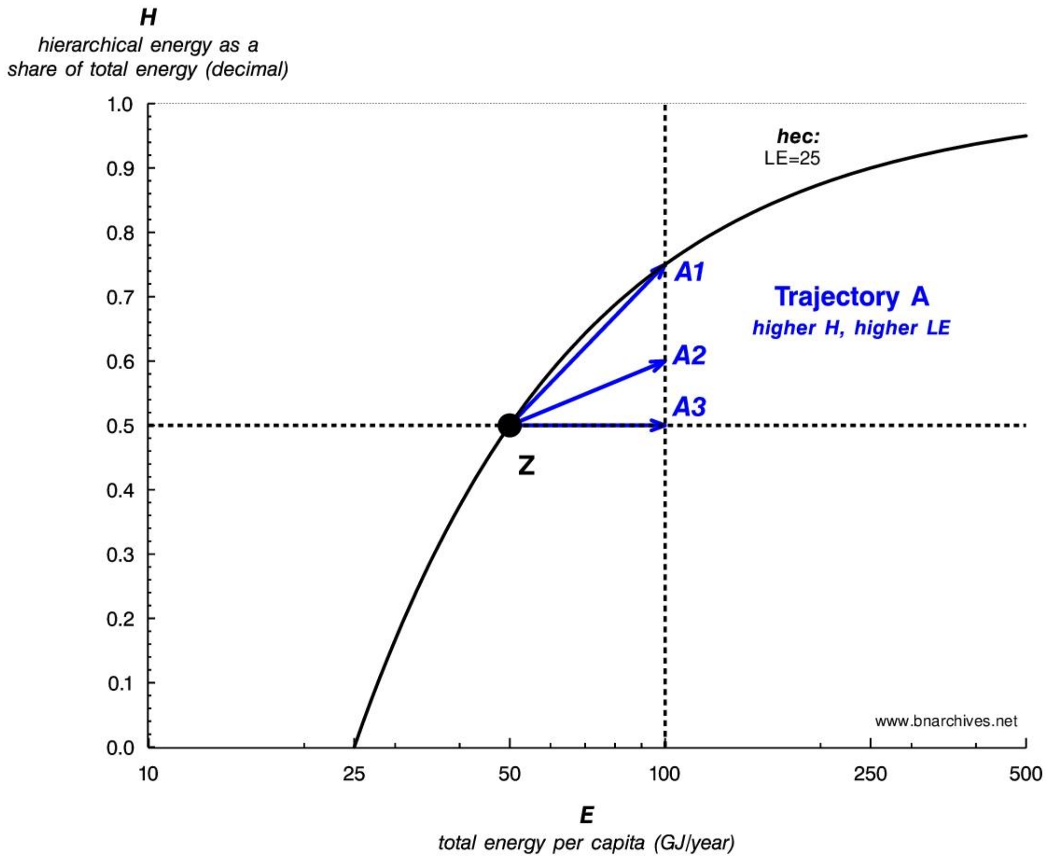


Table 3: Three Trajectories in an Expanding Mode of Power

	Total Energy per capita E		Livelihood Energy per capita LE		Hierarchical Energy as a Share of Total Energy H	
	Level (GJ/year)	Growth Rate	Level (GJ/year)	Growth Rate	Share (decimal)	Growth Rate
Trajectory A1	100	+ 100%	25	0%	0.75	+ 50%
Trajectory A2	100	+ 100%	40	+ 60%	0.60	+ 20%
Trajectory A3	100	+ 100%	50	+ 100%	0.50	0%

Recall that, according to the economies-of-scale argument, the correlation between energy and hierarchy is rooted in organizational effectiveness: hierarchy is seen as the most effective way of coordinating large-scale human endeavours, so the more hierarchical the society, the greater its energy capture per capita (depth). Based on our *power* rationale here, though, the causal chain runs in reverse. Power hierarchies, we argue, are built not to increase energy capture per capita, but for their own sake. Erecting and maintaining these hierarchies, however, requires plenty of strategic sabotage, and strategic sabotage – and this is the key link here – requires lots of energy.

This latter requirement means that hierarchy is capped, literally, by the ability of society to 'fuel it', and that cap, together with the drive for power, explains why higher energy per capita both enables and tends to correlate with more hierarchy. (The determinants of energy capture per capita – including the specific mix of hierarchy and cooperation – are of course important. But since the ultimate goal here is not more energy, but greater power, these determinants are perhaps better examined as means to an end rather than the end itself.)[29]

What determines the trajectory of an expanding mode of power such as capitalism? At the most general level, we can think of two contradicting forces: the Machiavellian drive to augment power for its own sake, and the opposing quest, pointed out by de La Boétie, to undo power and augment autonomy (see Subsection 4.2).

The Machiavellian force, whether deliberate or emergent, constantly pulls the mode of power toward the *hec*, so that more and more of the per capita energy can be used for hierarchical ends. This drive, though, is self-limiting. Over the longer run, more hierarchy requires faster energy growth – yet, as we suggested in Sections 5 to 7, too much hierarchy might undermine the capturing of energy per capita and therefore serve to *restrict or even reduce* energy growth (compared to what might be achieved via autonomous cooperation). If this suggestion is correct, moving on or close to the *hec* could end up limiting the pace at which the mode of power moves to the right and, by extension, its ability to augment its hierarchies. Moreover, and importantly, all else being the same, the closer a mode of power gets to the *hec,* the lower the growth of livelihood energy and therefore the greater the potential resistance; and since greater resistance tends to require more energy to sustain any given level of hierarchy, the ability to boost hierarchy is restricted even further.

The second, negating force – de La Boétie's quest for autonomy – pushes the mode of power in the opposite direction. Most of the time, this quest for autonomy is latent and largely invisible. But occasionally it erupts, usually unpredictably, to stir society, if only for a brief historical moment, toward greater creativity, cooperation and self-rule (Nitzan and Bichler 2009: 19-21).[30]

Now, on the face of it, the two forces negate one another: Machiavelli's gravitational force pulls the mode of power toward the *hec* (*Trajectory A1*), while de La Boétie's repelling force pushes it way from the *hec* (toward *Trajectories A2* and ultimately *A3*). On a deeper level, though, the relationship between them might prove more complex. As noted, one of our propositions in this article is that the energy capture per capita is affected by *both* hierarchy and cooperation, and that excessive hierarchy might actually *undermine* this efficiency.[31] Paradoxically, however, this co-

[29] The energy constraint on hierarchy is alluded to – though from a totally different perspective – by Fix (2017: Appendix I). To illustrate his argument, Fix models a fictional feudal/agricultural society. For simplicity, the model assumes that only the lowest level of the hierarchy – the serfs – produces energy, while the remaining levels merely consume it, and then goes on to compute the minimum level of per capita energy necessary for a given level of hierarchy. This model, though, does not reflect the fact that hierarchies generate resistance, and that overcoming this resistance requires energy *over and above* that consumed by the higher strata of the hierarchies – regardless of whether these strata themselves contribute to production or not.

[30] Some of the more well-known eruptions of this kind include the events leading to the Second English Civil War of 1648-1649 and the creation of the Commonwealth of England, the 1789 onset of the French Revolution, the Haitian slave rebellion of 1791-1804, the European revolutions of 1848 (the so-called Spring of Nations), the Paris Commune of 1871, the 1905 Russian Revolution, the Hungarian Revolt of 1956, the Prague Spring of 1968, the May 1968 uprising in France, the late 1970s insurrection against the Shah of Iran, the anti-communist wave of the 1980s, the Korean student uprising of the early 1980s, the First Palestinian Intifada of 1988 and the Arab Spring of the early 2010s.

[31] Since autonomous cooperation can use hierarchy if needed but hierarchy can rarely if ever invoke autonomy (Section 5.1), it follows that, in principle, an autonomously organized society can match or exceed the per capita energy capture of a hierarchical mode of power, if it so chooses. Whether this choice, with all of its ramifications, is deemed desirable in practice is of course another matter altogether.

determination means that, over the longer haul, de La Boétie's repelling force might end up *boosting* hierarchy. By pushing society's trajectory down from and to the right of the *hec*, this force reduces the energy share of hierarchy H, leading to less hierarchy and more cooperation. And if this shift toward greater cooperation ends up increasing energy per capita E, the ever-present Machiavellian force is likely to kick back, pulling society back toward the *hec* – though at a *higher* H than before. With this in mind, we shouldn't be surprised to see modes of power with a history of open contestation end up being *more* hierarchical than those whose hierarchies remain undisturbed.

At this point, our framework is too rudimentary to allow further analysis of these two forces. What we can say, however, is that in order for a mode of power to continue to expand within the confines of *Trajectory A*, the balance between these two forces has to change in line with the mode of power's position in the *hes*: de La Boétie's repelling force must strengthen and eventually exceed Machiavelli's gravitational force the closer the mode of power gets to *Trajectory A1*; and, conversely, Machiavelli's force must become stronger and ultimately surpass de La Boétie's as the mode of power approaches *Trajectory A3*. If this relative strengthening/weakening fails to occur, the mode of power will either fall into crisis (*Trajectory B*) or democratize (*Trajectory D*).

11.2 Crisis

The potential for crisis emerges when the share of hierarchical energy increases while the level of livelihood energy declines. This situation is illustrated by *Trajectories B1* and *B2* in Figure 7. Recall that when a mode of power moves up and to the right on the *hec*, the entire increase in total energy per capita goes to hierarchy while livelihood energy remains unchanged. *Trajectory B1* represents the 'tipping' of this borderline case: energy per capita is still growing, along with the share of hierarchical energy, but livelihood energy, instead of remaining constant, is now falling.

This decline is an invitation for trouble. As noted, in historical modes of power, rulers and subjects do not fight over the same thing and therefore rarely speak the same language: the subjects, preoccupied with their own material conditions, talk in absolute terms of wellbeing, while the rulers, obsessed with power, denominate their aspirations, actions and achievements in differential terms and relative positions. Now, as long as livelihood energy per capita is rising (*Trajectory A*), most subjects remain busy with their daily lives, paying little or no attention to expanding power, rising hierarchy and growing sabotage. But when livelihood energy per capita comes to a standstill (movement on the *hec*), the conflict between the two groups suddenly sharpens into focus; and when livelihood energy actually drops (*Trajectory B1*), the clash between wellbeing and hierarchical power comes to the fore.

At this point, the rulers face a systemic crossroad. They can relent by restricting the share of hierarchical energy in order to allow livelihood energy per capita to recover and perhaps even grow (i.e., shifting the mode of power back to *Trajectory A1* or even *A2*) – a move that might also help boost total energy per capita (assuming that less hierarchy and more autonomous cooperation make for greater societal flexibility). Or they can remain unrelenting, allowing the situation to devolve into a full-blown crisis. In this latter case, the atmosphere becomes combative, the rulers harden their stance even further, and the share of hierarchical energy continues to rise. This further diversion creates a toxic combination of rising sabotage and falling livelihood energy, which in turn undermines the cooperative aspects of production. At this point, the conversion of energy – which previously was still rising – might start to decline, and when that happens, the mode of power shifts from a tentative crisis (*Trajectory B1*) to a full-blown one (*Trajectory B2*). Total energy per capita is now contracting, and if the rulers, feeling under assault, fortify their power with even more hierarchy, livelihood energy, which previously declined only slowly, is bound to drop rapidly.

11.3 Decline

If the crisis is prolonged, there is now a distinct possibility that, instead of recovering, the mode of power will be sucked into a downward spiral and perhaps even terminal decline. Such decline is represented by *Trajectory C*. In this phase, all energy flows per capita – total E, hierarchical HE and livelihood LE – are falling. But unlike in the crisis phase, here hierarchical energy HE falls even faster than overall energy E, causing the relative share of hierarchical energy H to decline as well. This latter decline suggests that existing hierarchies can no longer be maintained and might start crumbling, breaking down into smaller, less complex assemblages. The mode of power, having been significantly weakened, becomes susceptible to a takeover by another mode of power (for example, the breakup of the Soviet Union and the absorption of its remnants into capitalism), or complete collapse (for instance, the fall of the ancient Roman Empire, the implosion and disappearance of the Easter Island society or the more recent failure of states such as Somalia, Congo and Southern Sudan, among others).

11.4 Democratization

The radical alternative to crisis and decline, situated on the opposite side of the *hes*, is a shift toward democratization, represented by *Trajectories D1* and *D2*. We use the term 'democratization' here not in the narrow and indirect sense of political representation, but in the broad and direct sense of ancient Greece's *demos-kratia*: the rule of the people themselves. From this viewpoint, a democratizing mode of power is one that reduces hierarchical power in favour of *direct self-rule and autonomous cooperation*, and which does so *throughout* society.

In terms of movement on the *hes*, the main hallmark of this trajectory is that livelihood energy and the share of hierarchical energy move in opposite directions, with LE rising and H falling. Like with the crisis phase, here too there are two distinct possibilities: the first, denoted by *Trajectory D1*, is one in which total energy per capita continues to increase, while the second, represented by *Trajectory D2*, is one in which total energy per capita declines.

Trajectory D1 is based on the premise, discussed in Sections 5 to 7, that societal efficiency in general and energy capture in particular are boosted by autonomous cooperation, and that under certain circumstances reductions in hierarchy might serve to augment total energy per capita. Thus, when the share of hierarchical energy H declines, livelihood energy LE gets a double boost – one from the redirection of existing energy, and another from the faster growth of total energy per capita.

A democratizing mode of power, though, can go even further by curtailing total energy per capita in the first place. This 'green' possibility is illustrated by *Trajectory D2*, a regime in which H and E are both falling, yet, since the contraction of the former is faster than that of the latter, livelihood energy LE is nonetheless rising.

12. Summary, Reflections and Extensions

12.1 Cognitive Dissonance

The late nineteenth and early twentieth centuries were marked by cognitive dissonance. While neoclassical economists and mainstream political theorists were busy concocting a rigorous mathematical ideology of a perfectly competitive economy nested in a *laissez faire* democratic polity (or vice versa), capitalism was moving decidedly in the opposite direction. One aspect of this movement was the rise of hierarchical organizations and large power coalitions, including giant corporations with transnational tentacles, large labour unions, political parties and government bureaucracies. The other aspect was a growing bellicosity fuelled by military build-ups, rampant racism and imperial wars. The picture-perfect Comtean vision of a flat, peaceful capitalism governed by voluntary productive interactions was overshadowed by an increasingly vertical reality of power, coercion and violence.

Liberals have reacted to this cognitive dissonance mostly by denying it. The problem, most of them insist, lies squarely with reality: instead of playing by the eternal liberal rules, it keeps distorting them. Fortunately, though, there is no reason to worry. In the long run, reality is deeply Galtonian: it always reverts back to its natural (read liberal) fundamentals. Thus, given enough time, Wilson's Fourteen Point plan was bound to establish world peace, just as the dynamic stochastic general equilibrium models of our central banks are bound to Pareto-optimize the global economy and restore its competitive 'micro foundations'. And if these long-term reversions nonetheless fail to occur, it is only because, as Keynes famously put it, '*In the long run* we are all dead' (1923: 80, original emphasis).

Critical political economists, particularly neo-Marxists and post-Keynesians, have presented a more sinister view. The rise of hierarchical institutions and organizations and the growing role of power and violence, they claim, were no accident. Capitalism, they argue, has been fundamentally transformed. Growing monopolization and the rise of large governments have shifted the emphasis from supply to demand. Instead of counteracting the falling tendency of the rate of profit emphasized by Marx, the key problem now is how to offset the system's rising surplus. And the main solution to this problem, many of them maintain, is institutionalized waste – primarily high military expenditures, an expanding financial sector and massive legitimation spending – activities whose ultimate role is to absorb the surplus without creating more of it (Bichler and Nitzan 2012b).

Note, though, that neither reaction questions the nature of capital itself. Both continue to treat capital as a 'real' *material-economic entity* rooted in production and consumption and therefore as *growth-dependent*. Power institutions and processes can affect this growth – and therefore capital – negatively or positively, depending on the theory, but the impact is always *external*: power in this scheme lies outside of capital, so its exercise has no bearing on the material-economic nature of accumulation as such.[32]

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[32] One of the few to realize the importance of this neglect was Paul Sweezy. In his assessment of *Monopoly Capital* (1966), a book he had co-authored with Paul Baran 25 years earlier, Sweezy admitted that there was something very big missing from the Marxist and neoclassical frameworks: a coherent theory of capital accumulation. His reflections are worth quoting at some length because they show both the problem and why economics as such is unable to solve it:

> Why did Monopoly Capital fail to anticipate the changes in the structure and functioning of the system that have taken place in the last twenty-five years? Basically, I think the answer is that

In this sense, the CasP approach is radically different. Here, capital is not a material-economic entity *affected* by power. It *is* power – and indeed nothing *but* power. From this viewpoint, the growth of hierarchy and the strategic sabotage it entails do not distort or prop accumulation; they *are* accumulation. Moreover, insofar as hierarchy and sabotage lessen societal efficiency and undermine growth, up to the strategic Goldilocks point of 'business as usual', the consequence is not to abate accumulation, but to *boost* it (Nitzan and Bichler 2000: Figures 5.1 and 5.2, pp. 79-80).

12.2 Inverting the Link

Our paper has both extended and transcended this claim. The question we have tried to address here is not why capitalism grows more *slowly* than it otherwise can, but how, with so much sabotage, it can grow in *the first place*.

Our first step in answering this question was to invert the conventional link between hierarchy and energy. The mainstream economies-of-scale theory, we pointed out, claims that social efficiency in general and the ability to capture energy in particular hinge on coordinating social complexity, and that the most effective way of achieving such coordination is through hierarchical organizations. This claim, we further noted, is consistent with the path-breaking research of Blair Fix, which shows that energy growth and organizational size/hierarchies go hand in hand. But then, causality – and here we come to the crucial point – could also run in *reverse*: where the conventional eye sees more hierarchy generating more energy, the inverted eye sees more energy fuelling taller hierarchies.

Our reason for inverting this link was twofold. First, social efficiency and energy capture, we argued, are often enhanced by autonomous cooperation. Second and more importantly, in the final analysis, hierarchical societies, including capitalism, are driven not by the desire for more energy as such, but by the quest for more power. Hierarchical power, though, and this is key, is always imposed against opposition, so its imposition depends on strategic sabotage; and since the exertion of strategic sabotage requires plenty of energy, hierarchy and energy capture end up being tightly correlated. In other words, energy still plays an important role, but as a means to an end rather than an end in itself.

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its *conceptualization of the capital accumulation process is one-sided and incomplete*. In the established tradition of both mainstream and Marxian economics, we treated capital accumulation as being essentially a matter of adding to the stock of existing capital goods. But in reality this is only one aspect of the process. Accumulation is also a matter of adding to the stock of financial assets. The two aspects are of course interrelated, but the nature of this interrelation is problematic to say the least. The traditional way of handling the problem has been in effect to assume it away: for example, buying stocks and bonds (two of the simpler forms of financial assets) is assumed to be merely an indirect way of buying real capital goods. This is hardly ever true, and it can be totally misleading. This is not the place to try to point the way to a more satisfactory conceptualization of the capital accumulation process. It is at best an extremely complicated and difficult problem, and I am frank to say that I have no clues to its solution. But I can say with some confidence that achieving a better understanding of the monopoly capitalist society of today will be possible only on the basis of a more adequate theory of capital accumulation, with special emphasis on the interaction of its real and financial aspects, than we now possess. (Sweezy 1991, emphasis added)

12.3 Waste as Investment

Viewed from this perspective, most of the expenditures that neo-Marxists and post-Keynesians consider wasteful might in fact qualify as proper investments. Nowadays, the term 'investment' is used to denote the creation of new productive capacity. But that was not always the case. In feudal Europe, where the term originally comes from, investment – or 'investiture' as it was then known – had nothing to do with production. Instead, it denoted *legal seizure*, pure and simple; an exclusive vested power over a given domain (Bloch 1961: 173; 349; Ganshof 1964: 97; 126; Nitzan and Bichler 2009: 227-228). And as Veblen pointed out, this essential feature remains unchanged: investment capitalizes earnings, and earnings are always generated and backed by the vested right to sabotage (Veblen 1923: 65-66).

Now, if we apply this latter criterion to what critical thinkers classify as institutionalized waste, we end up with a theoretical problem: based on this criterion, military expenditures, the legal system, financial intermediation, bureaucracies, advertisement, propaganda and religious organizations *generate* capitalist income; and according the theorists of institutionalized waste, activities that generate capitalist income cannot be deemed wasteful, by definition. Viewed from the perspective of capitalists, the key role of these activities is to bolster hierarchical power; and insofar as this bolstering translates into higher capitalized earnings, the activities that generate these higher earnings qualify as sound investments. Indeed, without these hierarchical investments there would probably be no accumulation of capital as power in the first place.

12.4 The Two Languages

Our second step in exploring the relationship of energy and hierarchical power was to separate energy capture into two distinct flows: hierarchical and livelihood. From a bio-physical perspective the two flows might look identical, but from a societal viewpoint they are very different, if not orthogonal. Livelihood energy affects the wellbeing of the underlying population, for whom the relevant yardstick is *absolute* (more joules). Hierarchical energy, by contrast, bolsters the power of the rulers, and since power is a differential entity, the proper measure here is *relative* (a greater decimal share of the total). In other words, from the very outset, we need not one language, but two – absolute for livelihood, relative for hierarchy.

Translating one language into the other, though, is not straightforward. On the face of it, both flows draw on the total energy of society, so one might expect that, for any given level of total energy, more livelihood would mean less hierarchy, and vice versa. But in general this is *not* the case. Since livelihood is absolute and hierarchical power is relative, more livelihood can go hand in hand with more as well as less hierarchy, just as more hierarchy can coexist with more or less livelihood, and it is this richer set of possibilities that needs be deciphered.

12.5 An Alternative Hierarchy-Energy Model

Our third step, then, was to outline an alternative hierarchy-energy model. The model, which juxtaposes and relates various combinations of livelihood and hierarchical energy, offers important insights into how modes of power operate and evolve. In its general form, this model can be used to examine capitalism as well as other modes power, and it can account for the full spectrum of hierarchy-energy trajectories. The following points summarize some of its key features and implications:

1. *Trajectories*. Based on its particular trajectory, a mode of power can be classified as expanding, in crisis, declining or democratizing.

2. *The two forces*. Modes of power are subject to two conflicting forces: a Machiavellian force that drives for more power hierarchies, and an opposing force, fashioned after de La Boétie, that seeks greater autonomy and cooperation. The balance of these two forces affects the particular trajectory a mode of power follows.

3. *Growing through sabotage.* In an expanding mode of power such as capitalism, the balance of these two forces allows both the hierarchical share of energy and the level of livelihood energy to rise. In this trajectory, the absolute flow of hierarchical energy *always grows faster* than total energy, which in turn means that headline measures of growth tend to *overstate* the growth of wellbeing, possibly by a very wide margin. In this sense, we can say that a mode of power grows, at least in part, not despite or because of sabotage, but *through* sabotage.

4. *Energy leads hierarchy.* Since erecting and maintaining hierarchies require energy, the growth of energy sets the upper limit on the growth of hierarchy. Now, since hierarchy is not necessarily the most effective way of capturing energy, and given the ever-present quest for more hierarchical power, it seems more likely that energy leads hierarchy rather than the other way around.

5. *The dialectics of resistance*. When successful, resistance to power tends to reduce hierarchy. This reduction, though, might not last for long: successful resistance augments autonomy, and if we are correct to argue that greater autonomy tends to boost the capture of energy, the result is to elevate the energy cap on hierarchy and therefore enable the erection of even *taller* hierarchies. This type of flexible zig-zag might explain why capitalist hierarchies, being subject to periodic contestations, are broader and taller as well as more resilient than those of other modes of power.

6. *Crisis and decline vs. democratization*. Left unchecked, the Machiavellian quest for ever more power invites crisis, and possibly decline and collapse. The opposite force, de La Boétie's quest for autonomy, offers an opening for democratization. Historically, the former force seems stronger than the latter: most modes of power expand, fall into crisis and occasionally decline and disintegrate; only on rare occasions do they move toward greater autonomy – and when they do, the experience is usually short-lived.

7. *Closed vs. open histories*. An expanding mode of power is locked into a narrow path where the hierarchical share of energy and the absolute flow of livelihood energy both rise. By contrast, crisis and democratization are more open-ended.[33] In both of them, there is a historical choice to be made. In the case of crisis, the rulers must decide whether to lessen their pressure and allow livelihood energy to re-expand, or press for even taller hierarchies at a risk of systemic disintegration and decline. Similarly with democratization. Here, it is

[33] We are indebted to Daniel Moure for pointing out this important difference.

the contesting underlying population that faces a choice: it can either allow total energy per capita to continue rising (and in so doing leave the door open for taller hierarchies in the future), or it can intensify the pressure toward a green, de-growth society and the radical dismantling of hierarchies.

12.6 Looking Ahead

The organization of society in general and its hierarchical structures in particular are intimately connected to energy. Without understanding this crucial connection, any effort to fundamentally change society is likely to be futile at best and disastrous at worse. And yet, as it stands, this connection, particularly when applied to the rapidly changing capitalist epoch, remains highly opaque: we know scarcely anything about hierarchies; save for broad generalizations, we know even less about the social role of energy; and we are pretty much in the dark regarding the way in which they intertwine.

The challenge here is both theoretical and empirical. The innovative work of Blair Fix shows that the size and inner hierarchies of corporations and governments are positively correlated with total energy per capita. But this is merely the bottom of the hierarchical iceberg. The micro hierarchies of organizations are themselves nested in meso and meta hierarchies that rank and connect organizations, ideas and the societal algorithms that govern their actions, and this full-spectrum hierarchy is yet to be conceptually and empirically mapped, even tentatively.

The other challenge is to theorize and measure the basic split between hierarchical and livelihood energy. As noted, this split is always coloured by our theoretical and ideological dispositions and can therefore never be entirely objective. But given its crucial importance for understanding power and resistance to power, it is necessary that we conceive of ways to define and quantify it, however broadly and inaccurately.

Contemporary capitalism seems to be pushing the natural and theoretical envelope. Its growing energy capture threatens the stability of the planet's biosphere, resources and climate, while its ideology denies that, soon enough, this entire regime is bound to come to a screeching halt. The math on this matter is straightforward. If overall energy capture continues to expand at the same rate it has grown over the past century (roughly 2.3 per cent a year):

> In 275, 345, and 400 years, we demand all the sunlight hitting land and then the earth as a whole, assuming 20%, 100%, and 100% conversion efficiencies, respectively. In 1350 years, we use as much power as the sun generates. In 2450 years, we use as much as all hundred-billion stars in the Milky Way galaxy. (Murphy 2011)

The conventional view is to blame this impasse on 'our wants'. Even Earl Cook, one of the first to map the history of energy capture, fell into this neoclassical trap of eternally 'unsatiated desires':

> The more power an industrial society disposes of, the more it *wants*. The more power *we* use, the more *we* shape our cities and mold our economic and social institutions to be dependent on the application of power and the consumption of energy. (Cook 1971: 140, emphases added)

But as this article has tried to point out, the real force driving this process is not our hedonic desires, but the rulers' quest for power. Much of the energy captured by humanity is not used to improve livelihood, but to fortify hierarchies, not to boost wellbeing, but to fuel strategic sabotage. For the vast majority of the world's population, this energy is best left uncaptured.

But in order for us to move in that direction, we need to understand how energy is used to subjugate us. Without this knowledge, even if sketchy, we will continue to think and act blindfoldedly. We will be unable to understand how hierarchical energy evolved in earlier modes of power; we will have only a partial and misleading understanding of how it supports the full-spectrum hierarchy of capitalism; and most importantly, we will be unable to imagine non-hierarchical structures that might stand against and perhaps replace capitalism.

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