On the wisdom of algorithmic markets: governance by algorithmic price

Pip Thornton[1] and John Danaher[2]

Abstract

Leading digital platform providers such as Google and Uber construct marketplaces in which algorithms set prices. The efficiency-maximising free market credentials of this approach are touted by the companies involved and by legislators, policy makers and marketers. They have also taken root in the public imagination. In this article we challenge this understanding of algorithmically constructed marketplaces. We do so by returning to Hayek's (1945) classic defence of the price mechanism, and by arguing that algorithmically-mediated price mechanisms do not, and probably cannot, accumulate and signal that same kinds of knowledge that Hayek felt were essential to effective market governance. Indeed, we argue that algorithmically-constructed marketplaces are closer to, though distinct from, the central planning model that Hayek critiqued. Regardless of how you feel about Hayek's argument, this has important consequences for how we respond to the rise of algorithmic governance tools in both markets and elsewhere.

[1] Pip Thornton is a PhD candidate in Geopolitics & Cybersecurity at Royal Holloway, University of London.
Email: pip.thornton.2013@live.rhul.ac.uk
[2] John Danaher is a lecturer in Law at National University of Ireland, Galway.
Email: john.danaher@nuigalway.ie

Introduction

In September 1945, Friedrich von Hayek published his most famous paper 'The Use of Knowledge in Society'. In it, he made a bold claim about the information processing powers of the free market. He argued that the market's price mechanism collated and communicated information from diverse sources, thereby enabling people to better coordinate their actions to mutually beneficial ends. By this logic, the price mechanism was a governance tool par excellence, one that could be used to accumulate and communicate important knowledge across society. Hayek used this 'Knowledge Argument' to critique centrally controlled governance tools, arguing that they could never perform the same kind of information-processing feats at could the market (Hayek 1945).

We live in an era characterised by the use of another information processing tool in governance: the computer-coded algorithm (Danaher 2016; Pasquale 2015; Rouvroy 2013). In our networked and digitised age – an age in which nearly every move we make and breath we take is recorded and logged in a digital repository – we have come to expect, and possibly even demand, automated algorithmic assistance. We look to the information processing powers of big data algorithms to help us make sense of the complexity we have created. These algorithms feed us information, often packaged into simple metrics like scores and ratings, that we use to coordinate and cooperate with one another, and to facilitate the smooth running of our everyday needs and consumption. As Karen Yeung (2017) notes, these algorithmic decision-systems:

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manage risk or alter behaviour through continual computational generation of knowledge from data emitted and directly collected (typically in real time on a continuous basis) from numerous dynamic components pertaining to the regulated environment in order to identify and, if necessary, automatically refine (or prompt refinement of) the system's operations to attain a pre-specified goal.

There are many ways in which modern marketplaces are algorithmically mediated. Consumer information is collected by many suppliers and is often mined for useful patterns. Suppliers then push particular goods and services to consumers, or particular deals on goods and services, based on those patterns. This, in essence, is what lies at the heart of variable price algorithms. They try to use consumer data to segment the marketplace into different groups who are willing to pay different amounts for the same good or service. Any business owner can download a software program that will automatically perform this kind of variable pricing for them. Likewise, there are many markets in which automated, algorithmically guided systems do the buying and selling, and thereby affect the market-clearing price of a good or service. The automated trading algorithms used on the stock market are the most obvious examples of this.

All of these markets involve a form of algorithmically-mediated pricing insofar as algorithms have some effect on market price, but they are not the most interesting or significant kind, nor the kind that we focus on here. The most interesting and significant kind are what we call 'algorithmically constructed market places'. These marketplaces are constructed by large digital platform

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providers, such as Google, Uber, Facebook and Amazon, and are used to match consumers to suppliers (where the suppliers are sometimes the platform providers themselves) via a shared platform. Algorithms construct this type of marketplace because they are used to set the prices that suppliers can charge and consumers can pay on that shared platform, and they also determine what kinds of information are available and communicable to those participants. These constructed marketplaces often include other non-price based algorithmic scoring systems (e.g. rating systems) that match consumers to suppliers. As such, the entire experience of being a consumer or supplier on this marketplace is mediated through an automated algorithmic governance structure. This structure tries to *automate* the knowledge accumulation and signaling needed for the marketplace, rather than relying on traditional feedback loops and methods of algorithmic calculation.

What is particularly interesting about some of these new forms of algorithmic market governance is that they attempt to recreate, in automated form, the price mechanism beloved by Hayek, or to preempt our position, they attempt to recreate a *semblance* of the Hayekian model. While markets are not, and never have been, perfectly 'free' in a Hayekian sense, algorithmically mediated auctions and bidding processes, as well as algorithmically-controlled price-setting tools, are often touted and defended in Hayekian terms. This suggests that the creators of these algorithmically constructed marketplaces believe that there is no tension between this automated algorithmic governance and Hayek's preferred free market governance.

In this paper, we dispute this perspective. Contrary to the claims of these digital platform providers, we argue that there are considerable tensions between what happens on their algorithmically-constructed marketplaces and what Hayek said happened on a free market. To highlight this tension, we go back to Hayek's Knowledge Argument and argue that it can be turned against these platform providers. Our claim is that when you appreciate the logic and content of Hayek's original argument, you realize that algorithmic price-setting mechanisms do not (and probably cannot) share the benefits that Hayek claimed for the price mechanism. On the contrary, algorithmically-constructed price mechanisms suffer from many of the same limitations and distortions that Hayek lamented in centrally planned forms of governance.

In arguing this, we do not claim that digital platform providers are the exact equivalent of centrally-planned governments (though they may have aspirations in that direction),[1] but rather that Hayek's Knowledge Argument can be applied to different targets, something he himself recognized and has been pointed out by others (Bowles, Kirman and Sethi 2017, 216). In his day, the biggest threat to market governance came from central planning; in our day, we argue that it may well come from digital platform providers. Furthermore, it is important to realise that our argument critiques a particular rhetorical *defence* of algorithmically constructed markets and not necessarily the reality. We do not presume that markets are or can be perfectly Hayekian, nor do we posit that the algorithmic model is identical to the Hayekian model. Instead we question the quasi-Hayekian rhetoric that has grown up around these systems. We argue that this Hayekian rhetoric is often a smokescreen, an attempt to abdicate

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responsibility or accountability for what happens on an algorithmically-constructed marketplace. We consequently argue that this is problematic given the power that such perceptions might engender when touted, encouraged or facilitated by companies such as Google and Uber.

We defend this argument in three stages. First, we set out the context for interpreting the argument, explaining Hayek's *knowledge argument* in favour of free markets. Second, we defend our argument, using two examples to highlight the shortcomings of algorithmically constructed price mechanisms: Google's AdWords auction and Uber's surge pricing. And third, we consider the consequences of our argument, focusing in particular on why algorithmically constructed price mechanisms fail to meet the Hayekian criteria and what this means for political accountability and transparency in the age of algorithmic governance.

2. Understanding Hayek's Knowledge Argument

The argument we defend in this paper must be interpreted correctly. Our goal is to contribute to the understanding of the emerging phenomenon of algorithmic governance, not to further or denigrate Hayekian theory. We do this by looking at the logical and historical intersections, tensions, and overlaps between this contemporary phenomenon of algorithmic governance and longer-standing forms of market governance (Aneesh 2006 & 2009). We argue that contemporary algorithmic governance mechanisms cannot replicate the features of market governance that were touted by Hayek. We make this case by appealing in particular to Hayek's knowledge argument. Hayek's argument was

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originally used to critique centrally planned economies, but we argue that it can be applied to other targets, particularly to what happens on algorithmically constructed marketplaces. There is some irony to this because the use of digital surveillance and computational power was, historically, perceived as a way to overcome the knowledge problem identified by Hayek and seems to be perceived in that way by modern digital platform providers. It is, consequently, important to understand the key propositions and premises of Hayek's argument as well as some of the historical uses of that argument.

How Hayek's knowledge argument works

Hayek's knowledge argument has a simple structure. It starts with the observation that 'planning' is essential to any economy. Decisions (plans) have to be made about what goods and services to produce, how to produce them and who to produce them for. The question is who should do the planning (Hayek 1945, 520). When Hayek was writing there seemed to be two answers to that question. There were those who thought governments should do the planning (Lange 1936 & 1937) and those who thought that individual actors, free from government interference, should do the planning (Von Mises 1920 & 1922). Hayek sided with the latter. He argued that the planning problem could be distilled down into a knowledge problem (Hayek 1945, 519-520). The challenge for any putative planner was that there was lots of data (information) available to them, but not all of that data was interpretable or meaningful to economic decision-making (i.e. counted as 'knowledge').[2] The critical question, therefore, was not who was best placed to make use of existing data on resources,

productive processes and consumer preferences, but rather who was best placed to *discover* and *translate* data into knowledge, and communicate it to others.

The problem, according to Hayek, was that the knowledge required to plan effectively was dispersed throughout a network of actors and could only be discovered and rendered meaningful through market-based transactions:

> The economic problem of society is…a problem of how to secure the best use of resources known to any of the members of society, for ends whose relative importance only these individuals know. Or, to put it briefly, it is a problem of the utilisation of knowledge which is not given to anyone in its totality (Hayek 1945, 519-521).

To be more precise, Hayek argued that the knowledge required to solve the planning problem had three distinct properties (Bronk 2013; Hayek 1945):

Discreteness: It did not come in a single package; it was dispersed among many different actors, who had partial access to the totality.

Tacitness: It could not always be easily articulated or codified; it rested on practical know-how and subconscious, tacit understandings of how productive processes worked and how consumers behaved (cf. Polanyi 1961 and Autor 2014).

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Subjectivity: The values and preferences of consumers and producers were subjective – known ultimately only to themselves.

In addition to this, Hayek argued that much of the knowledge had yet to be discovered: you needed the competitive ethose of the market to get people to exert the effort needed to discover it.

Once these properties are appreciated, Hayek's knowledge argument in favour of free markets is easy to make. Hayek claimed that central planners were ill-placed to discover, collate, and communicate the forms of knowledge needed to solve the planning problem. They could not hope to amass the discrete perspectives of many individuals into a single coherent plan for the market; they could not codify and articulate the tacit knowledge that underlay many market processes; and they could not hope to know the minds of the market actors. Free markets could do a better job.[3] Free markets had a wonderful knowledge accumulation and communication device at their heart: the price mechanism. The discrete, tacit and subjective knowledge of market actors could be translated into prices. These prices would tell people which goods and services were worth producing and supplying, and which were worth buying. This would enable market actors to coordinate towards mutually beneficial ends. Any interference from a central planner with the price mechanism would necessarily disrupt and distort the knowledge accumulation and communication functions that the price mechanism performs, sending people off in the wrong direction, leading to the over- or under-production of vital goods and services. On top of this, Hayek felt that free markets incentivised innovation and creative destruction, which

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enabled new knowledge to be discovered and to be entered into the market. This was something that centrally planned economies could never adequately recreate.

Hayek's argument can certainly be criticised. In its initial formulation, it was used to critique centrally planned economies, but it clearly has broader implications: it can be used to challenge any system that distorts the knowledge discovery, accumulation and communication functions needed for effective economic decision-making. Indeed, as Bronk (2013) and Bowles, Kirman and Sethi (2017) point out, the price mechanism can be distorted by market forces as well as by government forces. In particular, they suggest that information cascades and price speculation can lead to distortions of the knowledge provided by the price mechanism, which may point to a role for government interference in maintaining the knowledge accumulation and communication powers of the market. In other words, both sets of authors think the Knowledge Argument is separable from the free market ideology defended by Hayek, and can be used to challenge what happens among private actors on the market as well as what happens when governments interfere. We take a similar position here. We think that the Knowledge Argument can be used to critique more than just centrally planned economies. In particular, we think it can be used to critique the algorithmically constructed marketplaces created by large digital platform providers. This obviously involves a shift in focus from what concerned Hayek. Hayek's argument was focused on the economy as a whole, not on the markets for particular goods and services. The examples we discuss below will be focused on particular markets (e.g. the market for online advertising). Nevertheless, we

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think that Hayek's argument, because it can be separated from its original application, is a useful model for understanding and critiquing the claims made on behalf of these specific algorithmically-constructed marketplaces.

In addition to this general point about separability, there are two additional reasons for thinking that the Knowledge Argument is an appropriate tool for critiquing the practices of these digital platform providers. First, the companies in question are large and provide platforms that capture quasi-monopolistic shares of relevant markets and so the analogy between what they do and what happens in a centrally-planned economy is not inapt.[4] Second, the companies, and their boosters, often defend their algorithmically-constructed marketplaces on quasi-Hayekian terms and are encouraged to do so by regulators and legislators. It seems important then to critically probe the basis for this rhetorical defence. Doing so, we believe, shows that the rhetorical defence is flawed:mthe Knowledge Argument actually tells against what these companies are doing.

To make this point, we need to highlight three features of the knowledge argument. The first is the *coordinating power* that the argument ascribes to the price mechanism. It claims that prices work as signals, telling people what they should do, and encouraging them to do so in an efficient fashion. The second is to highlight the *knowledge accumulation* power of the price mechanism. By observing fluctuations in prices, Hayek is claiming that we learn something important about the discrete, tacit and subjective forms of knowledge that are often neglected, ignored or distorted by central planning. The third is to highlight

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the knowledge creation power of price competition on the market. By incentivizing people to compete with one another to make profits, the market incentivizes people to discover knowledge that previously did not exist. This was important for Hayek because the pre-existence of such knowledge is something that is often assumed by central planning models, as well as mainstream equilibrium theory (Bowles, Kirman and Sethi 2017, 218). Our claim in what follows is that algorithmically constructed marketplaces, of the sort used by Google and Uber (in particular) fail to adequately perform these functions.

3. The unwisdom of algorithmic prices: the case of Google and Uber

Before we get to the specific critique of digital platforms, it will help if we take a brief detour into the nature of the algorithmic governance mechanisms they use to construct their marketplaces, and the historical association between these mechanisms and centrally planned economies. Doing so will highlight some of the ironic historical development of the rhetoric around the use of algorithmic governance mechanisms in markets. This irony is something we wish to accentuate by turning the Knowledge Argument against purveyors of algorithmically-constructed marketplaces.

Terminology is important. We use the term 'algorithmic governance' in a narrow way. 'Governance' is a catch-all term for the techniques and practices whereby human behaviour is nudged, incentivized, manipulated and otherwise controlled. In a trivially broad sense, most governance-related decision-making

is algorithmic: it takes inputs and produces outputs by following a series of decision rules. Sometimes these rules are explicit, in which case the 'algorithmic' nature of the decision-making is transparent; sometimes these=rules are tacit or unexpressed, in which case the algorithmic nature of the decision is masked or hidden, though it may be rendered explicit by careful observation and study. This is true both for bureaucratic decision-making for the price-setting decisions made by economic actors every day. A person running a bakery, for example, must use *some sort of* algorithm to determine how much they will charge customers for bread on a daily basis (e.g. they may have a minimum profit margin target and so they compute price based on production costs and this minimum target).

If our discussion and critique were about algorithmic governance of this trivially broad sort it would neither be interesting nor insightful. So it should come as no surprise that we do not use the term in this trivially broad sense. When we talk about 'algorithmic governance' mechanisms we are talking about a specific, relatively recent, technological infrastructure for governance that relies on computer-coded algorithms (Danaher 2016; Levy 2017). To be more precise, we are talking about a mode of governance that is made possible by modern information communications technology, specifically Big Data systems, which work via a combination of mass surveillance and collation of data from networked technologies (computers, phones, smart devices etc.) and data-mining (descriptive and predictive analytics). The algorithms that power such systems rely on statistical analysis and statistical learning rules. These are 'smart' and adaptable, often adjusting and tweaking their own operations

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without immediate input from their original creators. Such systems are increasingly familiar, with virtually every internet company or service provider taking advantage of them in marketing and selling to consumers. Governments are also taking advantage of them in making risk-related decisions, such as who to audit for tax purposes, who poses a terrorist threat, who should be released from jail and so on (Ferguson 2017; Eubanks 2018; O'Neil 2016).

In his study of the rise of these contemporary algorithmic governance systems – which he terms 'algocratic' systems – A. Aneesh (2006 & 2009) contrasts them with pre-existing governance structures. In particular, he contrasts them with market-based governance structures and legal-bureaucratic governance structures. The former are characterised by their use of the price mechanism to 'govern' human behaviour; the latter by their use of rules and laws. He argues that algocratic governance constitutes something new: the use of computer-coded architectures to govern human behaviour. These new systems then work alongside the old governance structures, sometimes being grafted on top of them, and sometimes complementing them (Danaher 2016), creating multiple interlocking and overlapping layers of governance in human life.

The critical question for us is this: are these newer modes of algorithmic governance compatible with Hayekian-style market-based governance – as purveyors of digital platforms seem to be believe – or are they in tension with them? Can you simply recreate the virtues of the market through an automated, algorithmically constructed price mechanism? Or is this project doomed to failure? The answer might seem obvious if we consult the historical record. The

early use of automated systems of algorithmic governance seemed to be very closely-aligned with centrally-planned, bureaucratic modes of governance. In many ways, the quantitative, statistical models used in the early iterations of algorithmic governance structures were the bread and butter of the central planner, as Hayek himself pointed out (1945, 524; 1989).

Furthermore, if we look into the history of socialist governance we see some obvious attempts to use information communications technology to solve the knowledge problem that Hayek identified and to enable socialism to flourish. The clearest example of this is in the Cybersyn project run by the Allende government in Chile in the early 1970s (Medina 2011; Morozov 2014), which was designed to be 'a real-time control system capable of collecting economic data throughout the nation, transmitting it to the government, and combining it in ways that could assist government decision making' (Medina 2011, 3).

All of this suggests that the history of algorithmic governance is positively un-Hayekian, missing the benefits of the free market's price mechanism that he endorsed. But the historical tide has now started to shift. In recent years, several algorithmically constructed marketplaces have come into operation, and while market actors have been using algorithmic systems of calculation for years, what is important is that these newer systems are trying to replicate the benefits of the free market within the new digital infrastructures made possible by algorithmic governance technologies. This practice is defended on the grounds that it finds the most efficient 'market-clearing' price for a good or service.[5] Google, for example, sets up algorithmically mediated auctions to sell words to

potential advertisers. These auctions include a price-setting mechanism that tries to replicate the bidding process that might be expected to happen on a free market. Indeed, and despite Sergei Brin and Larry Page's original intentions to keep their search engine untainted by market forces (Brin & Page 2012, 3832), Google has defended the use of this algorithmically constructed auction in explicitly free market terms, claiming that a competitive auction leads to efficient pricing (Kordestani 2008). Also, Uber (the ride-sharing company) has gained notoriety for its 'surge' pricing algorithm that automatically increases and decreases the prices it charges for rides when there is over or under-supply. This practice is defended on essentially Hayekian grounds because it provides more information-rich signals to potential suppliers and consumers of taxi rides (Cohen et al. 2016). For example, a 2015 report authored by Uber-employed academics stated that 'economic theory tells us that using prices to signal to riders that rides are scarce and inducing driver-partners to forgo other activities will close the gap between supply and demand and lead to improved outcomes for both riders (as a whole) and driver-partners' (Hall, Kendrick & Nosko 2015). Hayek would certainly concur with the logic of this statement.

These are just some of the many examples out there. The rise of such algorithmically-constructed pricing mechanisms suggests that Hayek's original suspicions about quantitative, statistical models, and the historical association between cybernetic control systems and socialist forms of governance, are misplaced: if we are to follow the logic of these more recent efforts at algorithmic market governance, it would seem that the use of automated price-setting mechanisms, powered by big data algorithms, can actually help to perfect the

knowledge accumulation and communication functions identified by Hayek, at least within discrete markets. We would therefore be on the cusp of creating an ideal form of the Hayekian market in particular internet platforms, one stitched together through a Big Data infrastructure.

But is this really the case? Can we really perfect the information processing powers of the market through our modern technological infrastructure? We argue that this is unlikely. Algorithmic price mechanisms cannot accumulate and signal the kinds of knowledge that Hayek felt were essential to the success of free markets. Indeed, a proper understanding of Hayek's argument provides the tools for dismantling the claims made on behalf of such systems. We defend this position in three stages. First, we provide two examples of algorithmic price mechanisms in operation: (i) Google's AdWords auction; and (ii) Uber's surge pricing system. We highlight the ways in which both marketplaces involve distortions to the price mechanism that are prevent it from realizing the coordination, discovery and communication functions that Hayek highlighted. Then we defend a more 'in principle' critique of such algorithmically constructed price mechanisms, arguing that they will necessarily involve compromises that block the knowledge-generating virtues touted by Hayek.

Example one: Google's AdWords market

Let us start by considering the case of Google's AdWords market, the system used to sell advertising space on Google search results which Frederic Kaplan (2014) called 'the first global, real-time, and multilingual linguistic market'.

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Google AdWords operates on an auction model, whereby advertisers bid on the keywords most likely to attract customers to their adverts. Each time someone searches for a keyword on Google, a mini-auction takes place, and the advertiser who wins the auction has their advert displayed in one of a number of ranked spots at the top or bottom of the search page, made visibly separate from the non-paid organic results by a small Ad box next to the paid result. The winning advertiser pays Google one cent more than the second highest bidder every time someone clicks on the advert. In this way, the AdWords system supposes that 'every word of every language has a price, that fluctuates according to market laws' (Bruno 2012, 144).

Google claim that the AdWords auction provides a platform for free market competition which is 'by far the most efficient way to price search advertising' (Kordestani 2008). Distancing themselves from potential accusations of anti-trust and price-fixing over a potential ad-sharing deal with Yahoo in 2008, senior business officer Omid Kordestani confirmed that 'Google does not set the prices manually for ads; rather, advertisers themselves determine prices through an ongoing competitive auction' (Kordestani 2008). AdWords can therefore appear to be set up as the most efficient producer of 'commercial information' (Kordestani quoted in Battelle 2005), gathering signals from a distributed marketplace in order, as Google's then CEO Eric Schmidt put it 'to provide a platform that mediates supply and demand for pretty much the entire world economy' (in Battelle 2005, 248). The AdWords auction can therefore by seen as a clear attempt to instantiate Hayek's vision of the marketplace in an automated, algorithmically-constructed form (Mirowski 2009,

11). Although there are of course alternative search engines for advertisers and consumers to use, a recent US court case illustrates just how ubiquitous and normalised Google's algorithmic price-setting systems have become, and how their complete control over the market is increasingly being held by legislators and governments as providing conditions positive for fair competition. In the 1-800-Contacts case, an 'army' of Federal Trade Commission lawyers argued that Google was being unfairly harmed by the contact lens company 1-800-Contacts 'fixing' AdWords keyword search results by collaborating with other companies.[6] As the FTC's pre-trial brief states:

> [I]n addition to not being able to serve up a large volume of potentially relevant advertising, these artificially-imposed restraints hamper the search engines' ability to learn by analyzing what users are choosing to click on (or not to click on).... (FTC 2017, 22).

So not only did the FTC conclude that this was financially damaging to Google, but crucially, that by 1-800-Contacts meddling in the market, Google was being denied access to the information needed to provide consumers and advertisers with the correct information. This is revealing as it shows an implicit assumption on behalf of the FTC regulators that it is Google's role - and indeed responsibility – to maximize the analytic capacity of the search market, and that competition would 'hamper' this perceived right. Google is, as we have already mentioned, not the only search engine, but this case suggests that it is increasingly seen as such by a variety of actors, including regulators.

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But the reality is that, even without competition, AdWords is full of 'artificially-imposed restraints' on how knowledge is generated, accumulated, and communicated to buyers of advertising space. It is a distorted marketplace where Google's software engineers interpose their own knowledge and ideology between the advertisers and the consumers. The bid prices and auction-winning prices are not reflections of discrete, tacit or subjective knowledge about the value of certain words. The success of the platform lies not purely in a 'highest bidder wins' formula. The potential for adverts to win auctions (and therefore the top ad slots), or indeed to appear on the results page at all, will depend on a prior ranking of quality and effectiveness. As well as the bid price, adverts are given algorithmically-generated quality scores to determine what is known as their Ad Rank. A poorly performing advert will not necessarily be shown, even if its keyword bid won the auction. If it fails to attract enough clicks, it is not cost effective to host the advert, and more importantly, in free market rhetoric, it has not provided a good enough service; it has failed to read the signals from consumers. This sensitivity to distributed consumer feedback might seem like a self-regulating mechanism reacting to the knowledge produced by the market, but before the decision on whether to click on an advert or not reaches the consumer, the process has already been heavily mediated by the quality ranking algorithms, and by Google's own internal policies. The price is, consequently, not a pure reflection of distributed knowledge. This is far from the Hayekian ideal.

In addition to this, Google is constantly changing the goalposts in its constructed marketplace. Trying to keep on top of Google's evolving advertising systems has become an industry in itself. Search Engine Optimisation (SEO)

experts are in a constant struggle between penalisation for attempting to 'game' the system, and remaining visible amongst the search results. The rules of the SEO game are often modified or tweaked with no warning, and at great expense to advertisers, whose revenue streams can be drastically reduced when their adverts effectively disappear overnight. Many SEO forums contain discussions expressing outrage at any suspected artificial distortions of this perceived market, including accusations of cost per click (CPC) inflation caused by Google raising lowest bid prices in the face of increasing competition for finite linguistic resources.[7] Due to the opacity of the AdWords algorithms, it is of course almost impossible to empirically prove the anecdotes of frustrated SEO professionals, but they serve to provide an important insight into how 'narratives' can take hold in allegedly free markets, and how these narratives about the worth of certain keywords, and the functioning of the algorithm, can distort the knowledge generation, accumulation and communications powers of the price mechanism on the AdWords markets. The parallels with Bronk's claims about the role of narratives in distorting the knowledge communication function of stock market prices are striking (Bronk 2013).

Apart from potential internal manipulation of bid prices, certain keywords are removed from the marketplace entirely through Google's ethical policies on censorship. Google's current AdWords guidelines state that:

We value diversity and respect for others, and we strive to avoid offending users with ads, websites or apps that are inappropriate for our ad network. For this reason, we don't allow the promotion of any of the following:

- hatred; violence; harassment; racism; sexual, religious, or political intolerance or organisations with such views
- content that's likely to shock or disgust
- content that's exploitative or appears *to unfairly capitalise at the expense of others* [authors' emphasis] (Google 2016).

Of all the above opaquely and artificially-imposed restraints, perhaps the most pertinent is the banning of content which 'appears to unfairly capitalise at the expense of others' – the precise meaning of which is unclear, but certainly does not indicate that this algorithmic price mechanism would be able to collate the information necessary for the creation of true distributed knowledge.

So far from a 'free for all' marketplace, the mechanisms of Google's advertising are closely controlled and monitored. Google's 2015 year end US Securities and Exchange Commission report details how the company has been 'removing hundreds of millions of bad ads from [its] systems every year [and] closely monitoring the sites and apps that show our ads and blacklisting them when necessary to ensure that our ads do not fund bad content' (US SEC 2015). The list of prohibited keywords is perhaps understandably confidential in order to avoid manipulation of the system by advertisers, but this restriction is certainly not conducive to the creation of knowledge based on all available information.

Another apparent distortion of the linguistic market can be seen in Google Ad Grants, a scheme that allows non-profit and charitable organisations to use up to 10k dollars a month worth of AdWords for free. In effect, the scheme enables small groups and charities to enter into the paid ads market, but a $2 cap on these gifted keywords means that charities can lose out to big businesses – or even political parties- competing for the same word. Before the UK General Election in 2017, for example, a leading Alzheimers charity lost its AdGrants enabled spot at the top of the search results page when the three main political parties began bidding on the phrase 'dementia tax', thereby pushing the dementia charity to the second page of results (Thornton 2017). While Google's apparently philanthropic AdGrants system might be seen as a harsh, but competition-based marketplace, its distortion of the AdWords market, and its influence on the production of knowledge and information is potentially huge. In 2013 Google's UK Head of Public Policy Sarah Hunter (HAC 2013) told UK parliament that '[b]y the end of 2012 we had donated over $33 million to over 11,000 UK charities through giving them this free advertising'.[3]

But as we have seen with the 'dementia tax' example, Google AdWords can be used explicitly for political, rather than commercial advertising purposes, and indeed some Google AdGrants users are also actively encouraged to use their free keywords to fund and promote overtly political agendas such as anti-extremism campaigns. Developed in response to increasing government pressure to take more responsibility for potentially spreading radicalising

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[3] The wording is misleading here. There is no actual upfront donation of cash from Google. The 'donations' are in kind, and as such are artificially constructed market influences.

information, not-for-profit projects such as the 'Redirect Method' are given free AdGrants keywords in order to ensure that 'meaningful counter-speech' is returned in searches for potential terrorist or extremist material (HAC 2016). A search for 'Join ISIS', for example, would be 'redirected' - via the AdWords system - from an organic result, to specially curated content designed to counter the extremist narrative. The Redirect Method defends criticism of this manipulation of the market and potential discrimination against certain opinions with a curious neoliberal logic. Their method, they say on their FAQ page

> is the same tactic that businesses use to advertise to consumers…. [W]hile this method fuels a trillion-dollar ecommerce business, it's hardly been used as a tool to provide alternative messages to people who are looking for extremist content online (Redirect Method 2015).

In Google's algorithmically constructed marketplace, therefore, it seems it is acceptable to harness the power of the market to influence ideologies as well as consumer choice. These are, in effect 'centrally planned' schemes that actively bypass market mechanisms and prices. Some of Google's interventions might be laudable from a policy perspective, but by presuming they know better than the market, we end up with a mode of governance that is actually far from the Hayekian model.

Example two: Uber's surge pricing

The case of Uber is possibly more challenging. Started in 2009, the ride-sharing app Uber has been hailed as a challenge to the monopolies, regulations and

power of traditional cab companies. On the face of it, Uber's pricing mechanism seems the epitome of Hayekian ideals, purporting to respond to changes in information (in demand and supply patterns) faster than any individual human could do (Hall et al. 2015). Uber drivers do not need to rent expensive London hackney cabs, pay for extensive training and accreditation (as in the case of the Knowledge test that London cab drivers must pass), or buy the medallions that entitle New York taxi drivers to operate. Riders (customers) enjoy the benefits of apparently market-regulated cheap pricing, while drivers enjoy flexible working hours according to their economic needs.

To some, Uber is close to a perfect capitalist free market, where prices are determined not by price fixing or artificial regulatory interventions, but by the knowledge produced by supply and demand. According to Uber's former C.E.O. Travis Kalanick '[w]e are not setting the price. The market is setting the price' (Morozov 2014). Prices go up (surge) when demand goes up, and down when demand goes down, as explained by Peter Cohen et al. in their recent paper:

> A critical feature of Uber is that it uses real-time pricing ("surge" pricing) to equilibrate local, short-term supply and demand. A consumer wishing to take a particular trip can face prices ranging from the base price… to five or more times higher, depending on local market conditions (Cohen et al. 2016, 3).

Cohen et al.'s paper is based on analysis of data from 54 million Uber user sessions from Chicago, San Francisco, Los Angeles and New York in the first half of 2015. The much-coveted database was supplied by Uber - apparently after

many requests - to *Freakonomics* author Steve Levitt on the proviso that Uber employed economists would be involved in the analysis and resulting outcome. An interview with Levitt on the subject reveals his excitement at gaining access to such a unique database. Uber is, says Levitt, 'an economist's dream', or 'the embodiment of what the economists would like the economy to look like' (Levitt 2016).

The scope of the database made available to Cohen et al. showed not only fares that were taken, but the details of customers who opened up the Uber app, saw the surge price, and decided not to buy the product. This enabled Cohen and his co-authors to compare Uber customers who might face similar market conditions while being presented with different prices.

The report highlights several obstacles to the idea of Uber's surge pricing as an approximation of the Hayekian ideal. The prices charged are not organic, emergent properties of distributed interactions. Uber adopts artificially set base rate prices. This has an effect on its surge pricing system. It means that 'surge prices are always greater than or equal to 1.0, i.e. the price is never lowered below the base fare, even when market conditions suggest it should' (Cohen et al. 2016, 7). On top of this, Uber employs an incremental pricing structure which means that two customers 'in near identical market conditions' can be charged at different surge prices due to the way the system rounds up and down to discrete surge prices. This suggests some algorithmic distortion in the prices consumers are presented.

The purity of market regulated surge pricing is also currently being called into question by a class action in New York that alleges that it amounts to price fixing amongst drivers.[12] Furthermore, there is no transparency in the information available to either side, and no means of redress or control over the opacity of Uber's algorithmic decisions. In the Hayekian market, drivers would be free to adjust their prices in response to their own discrete, tacit and subject knowledge of the situations in which they act. Uber's pricing algorithm allows for none of this. The drivers have to 'game' the system if they hope to supply it with their knowledge. Uber's algorithm is therefore purporting to mimick the knowledge-accumulation and signalling of the marketplace while in practice administering a centrally planned system. It grows its business by offering reward incentives to new drivers, and reportedly withholding supply to drive up demand. The price mechanism is also distorted by the scoring system that runs side-by-side with it. Riders are encouraged to score drivers, and vice versa, and the algorithmically generated amalgams of these scores can then be used to inform future market decisions. While this kind of market produced information might seem helpful, and might be seen to correct for lacunae or omissions in the knowledge-accumulation powers of the pricing algorithm, it has the potential both to distort the market, and to limit the options of the actors within it. One Uber driver describes how 'he began to perceive the rating system not as a mechanism of mutual feedback, but of unequal power' (quoted in Knight 2016).

On top of all this, perhaps the most fundamental obstacle to viewing Uber's model as being regulated by the wisdom of prices, is a report leaked in early 2016 which revealed that despite its growth, Uber is failing to make a

profit. The company is instead running on an estimated $9 billion of venture capital investments, which in effect makes Uber insensitive to the price mechanism, and any market based analysis or defense of their operating system a moot point.[13]

Can algorithmic price mechanisms ever be Hayekian?

These two examples suggest that the practicalities of specific algorithmically constructed price mechanisms are far from Hayekian. But the case studies are not decisive. Google and Uber may intervene in their marketplaces and distort the prices charged in the manner of a central planner, but this does not mean that all algorithmically constructed price mechanisms are vulnerable to such distortion. Perhaps a system could be created that was closer to the Hayekian model?

We argue that this is unlikely. There are at least two reasons for thinking that algorithmically constructed price mechanisms will never have the same knowledge accumulation and signaling powers that the Hayekian price mechanism is alleged to have. The first reason for this is that algorithmic price mechanisms always *intermediate* between suppliers and consumers. Hayek imagined that prices were emergent functions of discrete actors working in response to local variations in discrete, tacit and subjective knowledge. Algorithmic price mechanisms might rely on mass surveillance technologies that aggregate from such discrete sources of information, but the algorithm's engineers (or the algorithm itself in the case of a machine-learning system) will necessarily suppose themselves to have some greater insight or knowledge than

Electronic copy available at: https://ssrn.com/abstract=3314078

these local actors. The algorithm will embed assumptions about the preferences of the market actors and make predictions about their future behaviour in an effort to better tailor the prices to the market. This might be a rational response to uncertainty about future behaviour (Bronk 2013), but it is contrary to the spirit and purity of the Hayekian model of the price mechanism.

The second reason for doubting the possibility has to do with the distinction between information and knowledge, and the specific types of knowledge that Hayek's argument focused on: the tacit and subjective forms of knowledge. Big data algorithms collect and organize objective quantifiable data. Consequently, they miss important sources of knowledge that Hayek held to be crucial to the price mechanism. They only collect and act upon information whose relevance was foreseen by the system's designers, and that can be seen and read by digital technologies. This has led to systems that omit important information and display systematic biases against certain populations (Crawford 2014; O'Neil 2016). These omissions might appear to be 'in principle' fixable. If we just improve the data collection technology and collect all sources of information (Mayer-Schonberger and Cukier 2013), we might be able to arrive at an algorithmically constructed price mechanism that truly reflected the distributed knowledge of the masses. But this is to miss the distinctive character of the knowledge Hayek concerned himself with. Say what you like about the Hayekian approach, it has a surprisingly humanistic and anti-objective ethos to it. As noted earlier, Hayek saw a distinction between information and knowledge. Knowledge was a qualitative interpretation or organization of information, and he claimed that there were specific types of knowledge that were available only

to humans in certain *'circumstances of time and place'* (Hayek 1945, 524). These are forms of knowledge not easily articulated or codified and that are ultimately subjective in quality. Given that algorithmic structures feed upon objective and codifiable forms of information, it is difficult to see how an algorithmic price mechanism could accumulate and signal the types of knowledge that Hayek felt were essential to price-oriented governance.

In sum, we think there are considerable tensions between contemporary forms of algorithmic governance and market governance, at least when the latter is understood in Hayekian terms.

4. What does this mean?

We want to close by highlighting some important consequences of the preceding argument for the future of algorithmic governance. Two consequences, in particular, stand out from what we have said.

The first is that we should be wary and suspicious of any claims made by proponents of algorithmic price mechanisms that tout their objective, knowledge accumulation and communication credentials. Both Uber's Surge and Google's AdWords represent the pricing algorithms they employ as an objective, motiveless agents. They claim that the algorithm reflects the wisdom of the masses not the policy preferences of the company. But this is clearly not true: both companies use the algorithms to implement policy preferences and ideologies. As Frank Pasquale (2016) notes, it is easy, and increasingly common, for corporations such as Google and Uber, to use both the market and the

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algorithm as 'excuses' for their behaviour, allowing the algorithm to masquerade as an objective regulator of individual behaviour. This creates a dangerous and oppressive precedent. As Ezrachi and Stucke remind us in their recent book *Virtual Competition*, the power behind algorithmic regulation is not the invisible hand of the market, but something perhaps far more insidious:

> what might at first glance be seen as competition is, in fact, the creation of a new force - the "digitalised hand'. That hand, controlled by algorithms, determines the market price in any given market through complex calculations. It is controlled by those who seek to maximise their profits (Ezrachi & Stucke 2016, 209).

The question might then be not only whether algorithmic governance structures can ever be compatible with a Hayekian version of market-based governance, but that if we are to accept a new hybrid 'digitalised hand', what knowledge does this type of market produce? And further to this, what epistemological power is vested in whoever controls the systems producing such 'knowledge'? As Mirowski and Nik-Shah warn us, the 'visible hand that fashions the auction believes it can govern the world' (2017, 8).

In answering these questions, we should also be wary of attempts made by digital platform providers to 'perfect' or 'complete' the databases of knowledge upon which they construct their algorithmic markets. It is unlikely that such attempts will fill the knowledge gaps needed for Hayekian efficiency. Excited by the rich source of data from Uber, Cohen et al. insist that 'better data

are the key to deeper insights' (2016, 22), but there is also an argument to say that more data, particularly data of the wrong type, produces poorer knowledge. More data also means infringements on privacy, something brought to light in Uber's retaining of location data from users' mobile phones for five minutes after the end of a journey or an interaction with the app, even when they did not accept the ride. Uber has also been repeatedly criticised for its 'God View' tracking ability that has been abused by employees.[14] This insistence on the need to see or collect as much data as possible in order for it to produce the best knowledge, would have been an anathema to Hayek, who rejected the idea that 'scientific' aggregate statistics could equal 'the sum of all knowledge' (1945, 521), instead believing in the importance of localised, subjective tacit knowledge. Indeed, if we look to Hayek's suspicions of statistics and scientific ways of trying to 'know' and 'see' everything of the central planning model, we can see not only Uber's God View- despite its protestations to the contrary- but also echoes of Donna Haraway's feminist critique of the God Trick, or the problematic claim to objectivity. To Haraway

> objectivity turns out to be about particular and specific embodiment and definitely not about the false vision promising transcendence of all limits and responsibility. The moral is simple: only partial perspective promises objective vision... Feminist objectivity is about limited location and situated knowledge (Haraway 1988, 582-3).

Thus in both Hayek and Haraway we can see a distrust of the obsession to see everything, or know everything, which we might extend to critique the

algorithmic God View of both Uber and AdWords and the increasing modern

obsession with big data.[15] To Haraway, what she calls 'unlocatable' knowledge

equals 'irresponsible' knowledge, and '[i]rresponsible means unable to be called

into account'. But this is perhaps the main problem with algorithmic governance

and its reliance on quantitative big data (and as much of it as it can get) – how

can it be called into account – especially when it operates under the guise of

market impunity?

The second consequence of our argument is that it forces us to reflect

once more on the relationship between algorithmic governance and other modes

of governance, and to question the traditional ideologies associated with them.

We have framed the argument in this article in terms of a simple, classic, binary

view of contemporary forms of algorithmic governance: are they (free) market-

based or (to some extent) centrally-planned? We suggested that they are not the

former, but our argument might also suggest that they are not the latter – that

we must move beyond the binary view and see algorithmic governance as

something genuinely new and different. As Lucas Introna and Helen Nissenbaum

identified, in the early days of the internet, information was pulled in two very

different ideological directions. On the one hand, a post-modern narrative saw

the opportunity for the dissemination rather than centralisation of knowledge,

but on the other hand, the private ownership of technology had a limiting effect

(2000, 170). Even before that, there was a confused ideology underlying the

development of networked technology, as demonstrated with the early

cybernetic projects such as Cybersyn, and perhaps the somewhat surprising

apparent harmony between Hayek and Haraway's views on situated knowledge

that we detailed above. Likewise, the advent of Web 2.0 brought possibilities of participation and inclusion, yet the privatisation of information by companies such as Google led to a 'dispossession' of the means of communication (Jakobsson & Stiernstedt 2010).

According to Philip Mirowski, the reason for ideological confusion is that computational systems and neoclassical views of markets are fundamentally incompatible. This is one of the reasons why 'there is not as yet a credible economics of knowledge' in the computational age (2009, 99).

> If the marketplace of ideas is thought to operate like a computer, and then one insists upon neoclassical economic theory as the correct and appropriate model of the market, then economists are dealing in delusion, since they regularly endow the market with capacities that no existing computer can or ever has possessed. Although it is not a popular opinion in the contemporary profession, it seems hard to escape the implication that neoclassical economics and computers just are incompatible. One may wish (as Hayek did) to portray the entire market institution as resembling a computer, but to do so, one must relinquish any commitment to the neoclassical orthodoxy (Mirowski 2009, 143-4).

So what then, can we say of an economics of algorithmic knowledge? Is there new wisdom in algorithmic markets? Perhaps the same problems exist today as they did when Hayek originally formulated the knowledge problem, for Cybersyn style central planners and for algorithmically governed markets. Not all information can (and perhaps needs to be) codified. Just because we have the

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means of codifying things in digital, algorithmic systems still doesn't mean that we can get at the discrete, tacit and subjective knowledge needed to create the perfect market (even if that was our objective). More (or bigger) data does not necessarily solve this problem, and such data will in any case always be affected by the biases and motives of the companies and individuals who create and automate the processing algorithms. What Google and Uber have created with tools such as AdWords and surge-pricing are not systems of algorithmic governance that level the epistemological playing field and provide efficient distribution of services through the price mechanism, despite the quasi-Hayekian rhetoric on which they rely. Instead, what we have argued in this paper is that any knowledge produced through such systems will necessarily carry the bias not only of its algorithmic structuring, but is also unreliable knowledge based on centrally planned constructed marketplaces and price setting interventions.

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[1] Certain digital platform providers seem to have the desire to control the marketplace for nearly all physical goods. The best example is, of course, Amazon which was partly inspired by Jeff Bezos's interest in creating an 'Everything Store'.

[2] As one of the reviewer's to this paper noted, there is a distinction between 'information', which is a quantitative concept and knowledge, which is more subjective and qualitative. Hayek's knowledge problem is about acquiring and communicating the latter, not the former (though quantitative information could of course be useful in doing this). This creates particular problems, as we note below, for algorithmic price mechanisms because they rely heavily on objective quantifiable data.

[3] We do not claim here, nor would Hayek have claimed, that free markets could 'solve' the knowledge problem. Unlike modern proponents of the efficient market hypothesis, Hayek did not believe that all knowledge was embedded in market prices. Some things were ultimately unknowable, and the reality of

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innovation and novelty meant that new knowledge could enter a market at any time.

[4] This is an observation that has been made by others. Ronald Coase, for example, argued that one of the points of contention between himself and Hayek arose from the fact that Coase viewed large firms as akin to miniature centrally-planned economies, but argued that centralizing some functions within a firm was efficiency-maximising because it minimized transaction costs (on this see Coase 1937 and Bowles, Kirman and Sethi 2017, 225). We discuss this in more detail below.

[5] The price of any good on a free market is, ideally anyway, determined by the interaction of supply and demand. Efficient prices are ones that increase consumer surplus (the gap between what consumers are willing to pay and what they actually pay) and producer surplus (the gap between the minimum price they would be willing to accept and what they actually receive). Variable price algorithms are used to set an efficient price that maximizes producer surplus. They do this by segmenting the market into different groups and exploiting the fact that some consumers are willing to pay more than others. This segmentation is usually claimed to be a net social benefit because the consumers who pay more can often subsidise lower prices for those who are willing to pay less.

[6] Eric Goldman (2017), describes the apparent volte-face of the US Government in their backing of Google in this case: http://blog.ericgoldman.org/archives/2017/04/ftc-explains-why-it-thinks-1-800-contacts-keyword-ad-settlements-were-anti-competitive-ftc-v-1-800-contacts.htm

[7] For example see: http://www.mediavisioninteractive.com/blog/paid-search/google-adwords-cpc-inflation/ (accessed December 15 2016).

[12] For example see: http://www.insurancejournal.com/news/east/2016/08/29/424673.htm (accessed December 15 2016).

[13] For example see: http://www.forbes.com/sites/briansolomon/2016/01/12/leaked-ubers-financials-show-huge-growth-even-bigger-losses/#405fe7b15c99 (accessed December 15 2016).

[14] For example see: https://www.theguardian.com/technology/2016/dec/13/uber-employees-spying-ex-partners-politicians-beyonce (accessed December 15 2016).

[15] Where Hayek departs (quite dramatically) from Haraway is in a complete disregard for the causation of subjective knowledge or the correction of its inequalities beyond the balancing laws of the market, criticism that could also be leveled at the central planning of Project Cybersyn.

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