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Economics, Complexity and the Disenchantment of the Social World

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The fact that we predict eclipses does not, therefore, provide a valid reason for expecting that we can predict revolutions. (Popper, 2002, p. 340)

Introduction

Even though he is widely considered to be the founding father of the economic discipline, Adam Smith would have a hard time finding a job at an economics department or getting his ideas published in any of the major economics journals, had he lived today. One of the central reasons for this is that neoclassical economics, which dominates the discipline today, and economics at the time of the great political economists such as Adam Smith and David Ricardo are differentiated by one single characteristic more than any other: their use of mathematics[1] (Schabas, 1989). While today's economics is best characterized as a thoroughly mathematical science, the writings of the classical economists were almost entirely discursive (Lawson, 2012; Hodgson, 2013).

This mathematical condition of modern economics has quite recently become the subject of heated debate and strong criticism in light of the economic crisis that has hit us in 2008 and still lingers on today. Many (i.e., Friedman, 1999, p. 137; Krugman, 2009a, 2009b) have argued that, caught up in more and more complex models, economics itself had become detached from its appropriate subject matter: real world economic problems. The economic science failed to make sense of our reality, and instead got lost in a different reality of their own making consisting of models and equations.

Such criticisms regarding the role of mathematics in economics and its inability to capture our economic reality are not, however, just something of the past seven years. Even though the role of mathematics has evolved to one of absolute dominance since the end of the 19th century, many have voiced criticisms towards this development. And the list of those critical of the mathematization of economics does not just name quirky heterodox economists at the margins of the discipline but also includes some of the most famous and important economists of the 19th and 20th century.

In this paper I will take a closer look at some of the concerns and warnings about the role of mathematics in economics put forward by Alfred Marshall, Friedrich Hayek and John Maynard Keynes. Specifically these economists have been selected because each of them has had a significant and constituting influence on the economic discipline, and because taken together they represent a substantial part of the diversity of the economic discipline at their time and today (i.e. Keynes' argument for the occasional government intervention versus Hayek's laissez-faire economy).[2] This paper will focus on the concerns they voiced regarding mathematics in economics, which were born out of their shared conviction of the complexity of economic reality. They argue that the world is too complex and varied for mathematics to be able to capture it, and that this thus poses limits to its use. They do not deny that mathematics can be useful but one must know its place and restrictions. In this respect they stand in sharp contrast to economic thinkers such as William Stanley Jevons, Irving Fisher, Paul Samuelson, Kenneth Arrow and Gerard Debreu, some of the founders of neoclassical mathematical economics, who believed that it was in fact possible to capture economic reality in mathematics and that it should therefore be adopted as the main engine of enquiry in economic science.

After discussing concerns regarding the role of mathematics in economics I will continue by addressing the question of why, seeing that both sides had respectable and important economists in their ranks, mathematics evolved to the dominant position it has today *in spite of* the concerns that were expressed. Why were these concerns put aside? As an answer to this question I argue that there existed and exists in economics a high demand for predictive power, which can be illustrated by Milton Friedman's famous and influential statement that the performance of a theory is to be judged only by its ability to predict (Friedman, 1966, p. 4). What was demanded of an economic theory was that it provided the ability to predict events in the social world. It is my claim that this demand for predictive power is and was the result of the attempt to bring the world under the mastery of "man": a process that Max Weber called "disenchantment" (Weber, 1958). I then argue that the reason the concerns voiced in the direction of mathematics were not able to stop its triumphal march to dominance is that these concerns were founded on ideas of real world complexity which were incompatible with this process of disenchantment and the demand for prediction that it entailed.

Economics, mathematics and the complexity of economic reality

Let me begin by discussing an opposition between David Ricardo and Thomas Robert Malthus. Though Ricardo is one of those classical economists whose work is almost entirely discursive and who did not specifically advocate the use of mathematics, he did uphold the view that (simple) models could somehow be representative of a wide set of varied and complex phenomena (Ricardo, 1817). In this aspect he is the opposite of one of his fellow classical economists, Thomas Robert Malthus, who held the view that economic reality was far too complex and varied to be captured in models. Malthus therefore concluded that simple formal models were at most of highly limited use (Malthus, 1820).

I introduce this contradistinction here because it is to some extent illustrative of the arguments and concerns that I will address in what follows. I do not mean it to refer to a distinction between inductivism and deductivism, and I do not argue that there exists a one to one relation between an inductivist position and positions preaching caution regarding mathematics in economics nor between the deductivist position and those promoting math (Hodgson, 2013). Rather, the distinction between Malthus and Ricardo is to be illustrative of two opposing positions regarding the possibility of capturing economic reality in mathematics that will be addressed in what follows.

So on the one hand there is the 'Ricardian' and so far victorious side of the story that believed that it is in fact possible to, putting it crudely, capture reality in a model. An important figure on the list of those subscribing to this line of thought is William Stanley Jevons, a famous 19th century economist who, by introducing his theory of marginal utility, was one of the first to provide an anchor for calculus and mechanical analogies in economics (Schabas, 1989; Hodgson, 2013). By arguing that it was possible to assign a number to the utility (pain or pleasure) that a person receives from a certain outcome, it became possible to introduce utility in mathematical economic models. And with the idea that utility was something that existed in reality, or was at least an analogy for something that existed in reality, came the idea that it was possible to capture economic reality in mathematics and mechanical analogies and the conviction that studying these would provide us with information about real world economic phenomena (Schabas, 1989).

Jevons' framework and ideas about mathematics being the primary engine of enquiry for economics were developed further in the late 19th and early 20th century by several important economists (such as Irving Fisher). However, it was not until the late 1950's that these ideas about the formalization of economics found their culmination in the works of economists like Kenneth Arrow, Gerard Debreu and Paul Samuelson, who established the foundations for post-war mathematical economic theory (Blaug, 2002, 2003). That this line of economists believed that mathematics was truly able to capture economic reality is nicely illustrated by the following statement made by Paul Samuelson in one of his early papers at Harvard:

> Mathematical methods properly employed, far from making economic theory more abstract, actually serve as a powerful liberating device enabling the entertainment and analysis of ever more realistic and complicated hypothesis. (Samuelson, 1939)

So for the young Samuelson, as for many of his colleagues at the time, it was clear enough: by using mathematics we are able to make our hypotheses match more and more closely to the way things actually are. It was believed (and is still believed by many today) that the models that mathematical economics produces would be able to capture something useful about economic reality when applied to it (Lawson, 1997; Hodgson, 2013). And so it was thought of not only as possible, but also as better to use mathematics to express oneself in economics. For most economists, to state a theory in terms of a formal model is an unambiguous improvement (Chick, 2001).

But this idea of mathematics being able to capture reality and thus being the ultimate engine to enquire about, it is not something that was without criticism. There were quite some economists who, like Malthus, emphasized that economic reality was too complex to be captured in mathematics, and that models are thus at best of highly limited use. Let us first turn to Alfred Marshall in that respect.

Marshall saw the limits to highly general 'pure theory' of the type found in the works of Ricardo and Jevons and though they were produced quite some time after his death, he would surely have found the same limits in the type of pure theory found in the works of economists like Arrow, Debreu and Samuelson (Marchionatti, 2004; Hodgson, 2013). In his letter to Arthur Bowley, the LSE's first professor of statistics, he wrote:

> I had a growing feeling in the later years of my work at the subject that a good mathematical theorem dealing with economic hypotheses was very unlikely to be good economics. (Pigou, 1925, p. 427)

Though some have also emphasized Marshall's role in the rise of mathematical economics (e.g. Schabas, 1989) it seems indubitable that he himself did not believe in a purely mathematical economic science and continuously emphasized the danger of formalization causing economic theory to stray away from real-life relevance (Marchionatti, 2004).

This does not mean that Marshall opposed the use of mathematics altogether. He simply held that it should not be the economists' principal engine of enquiry. One can, and according to Marshall should, use mathematics as a shorthand language for thinking (Schabas, 1989). But afterwards, he argued, one should always translate back to real world examples and "burn the mathematics" (Pigou, 1925, p. 427).

Now why is it that mathematics should not, according to Marshall, be our primary engine of enquiry? Why should we burn the mathematics and use it only as a shorthand language for thought? The reason for this is precisely that he believed mathematics was unable to capture economic reality (Marchionatti, 2004). Marshall thought that the economic world was far too complex to be represented in mathematics and that if we were to use mathematics as our primary engine of inquiry, we would not be enquiring about our actual world, but rather about some abstract and incomplete version of it (Marchionatti, 2004). According to Marshall, excessive reliance on mathematics would, in the words of Arthur Pigou:

> (…) lead us astray in the pursuit of intellectual toys, imaginary problems not conforming to the conditions of real life, and further, might distort our sense of proportion by causing us to neglect factors that could not easily be worked up in the mathematical machine. (Pigou, 1925, p. 84)

These factors that could not be easily worked up in mathematical machines are precisely those factors that characterize the complexity of economic reality. And it is economic reality rather than any abstract mathematical version of it that should, Marshall believed, be the primary subject of economics (Marchionatti, 2004).

Marshall's recognition of the complex character of real world economic systems is signaled by his invocation of biology rather than physics (Hodgson, 1993; Hodgson, 2013, p. 8). In his *Principles of Economics* Marshall wrote:

> Economics, like biology, deals with a matter of which the inner nature and constitution, as well as the outer form, are constantly changing. (Marshall, 1961, p. 772)

In an article in *The Economic Journal* in 1898 Marshall expressed a similar view. There, he wrote that:

> 'Progress' or 'evolution,' industrial and social, is not mere increase and decrease. It is organic growth, chastened and confined and occasionally reversed by decay of innumerable factors, each of which influences and is influenced by those around it; and every such mutual influence varies with the stages which the respective factors have already reached in their growth. (Marshall, 1898, pp. 42-43)

So instead of emphasizing the parallelism with physics like for example Fisher did, Marshall emphasized much more the similarities that economics shared with biology. And the resulting recognition of the complexity of the world led Marshall to be cautious of mathematics in economics. That is, it led Marshall to be cautious of using mathematics as a primary engine of inquiry. For him, the complexities of economic reality were not arguments against the use of mathematics in economics in general, and he did recognize that mathematics could be of great importance (Schabas, 1989). But these complexities did, according to Marshall, constitute limits to the employment of mathematics in economics (Marchionatti, 2004).

A similar emphasis on the complexity of economic reality and appreciation of economics' similarities with biology rather than physics we find in the works of Friedrich Hayek. Hayek continuously emphasized the difference between the social sciences and physics and criticized what he called scientism: the desire of economics to be like physics. He argued that mathematical economics would never be able to achieve the kind of completeness that physics could achieve:

> While in the physical sciences it is generally assumed, probably with good reason, that any important factor which determines the observed events will itself be directly observable and measurable, in the study of such complex phenomena as the market, which depend on the actions of many individuals, all the circumstances which will determine the outcome of a process, for reasons which I shall explain later, will hardly ever be fully known or measurable. (Hayek, 1989, p. 2)

The reason for that state of affairs, Hayek argues, is the fact that:

> (…) the social sciences, like much of biology but unlike most fields of the physical sciences, have to deal with structures of essential complexity. (Hayek, 1989, p. 4)

Like Marshall, this conviction of the complexity of economic reality led Hayek to have a resistance towards formal modeling. He did not oppose formal modeling in general, but he emphasized that there are limits to its use. He stated that as we advance towards more and more complex situations:

> (…) we find more and more frequently that we can in fact ascertain only some but not all the particular circumstances which determine the outcome of a given process. (Hayek, 1989, p. 7)

The desire to capture reality in mathematical models, Hayek argued, causes economics to neglect factors that cannot be easily incorporated in the mathematical machine. In Hayek's words:

> In the social sciences often that is treated as important which happens to be accessible to measurement. (Hayek, 1989, p. 2)

Much is thus left out when a model is created, and the more complex the situation that is modeled, the less the model is like that actual situation. Already in 1937 this was a criticism that Hayek voiced against much of the economic work that was produced at that time:

> More recent work has been freer from this fault [of mixing up the a priori and the empirical] – but only at the price of leaving more and more obscure what sort of relevance their arguments had to the phenomena of the real world. (Hayek, 1937, p. 54)

So we see an emphasis on the fact that important factors are left out in any model of a complex economic reality and the fact that this poses limits to the use of mathematics in economics. This emphasis is something that we also find in some of the works of John Maynard Keynes, whose views on the matter were deeply rooted in Marshall's (Marchionatti, 2009). Keynes' work as an economist was essentially an attempt to cope with the complexity of the economic world and the organic interdependence of variables, founded on a conception of economics as a science of social complexity (Marchionatti, 2009). In his 1939 article *On Professor Tinbergen's Method* he, like Hayek and Marshall, makes clear that if a model is to be representative of economic reality not only significant but rather all causes must be accounted for in the model and that furthermore all these factors must be measurable so as to be able to account for them in a precise mathematical way. It is highly unlikely that all the factors that affect a certain outcome are in fact measurable and even more unlikely that we know all factors that are involved (Marchionatti, 2004, 2009). Keynes states that:

> If we were dealing with (…) independent atomic factors and between them completely comprehensive, acting with fluctuating relative strength on material constant and homogeneous through time, we might be able to use the method of multiple correlation with some confidence for disentangling the laws of their action. (Keynes, 1973,p. 286)

But we are not. Due to the nature of economic material, a complete and exact generalization is not possible, and any model we create will thus be incomplete (Marchionatti, 2004). Additionally this means that neither a mathematical theory nor a prediction can be confirmed by data from economic reality:

> If the method cannot prove or disprove a qualitative theory and if it cannot give a quantitative guide to the future, is it worthwhile? (Keynes, 1939, p. 566)

With an almost audible 'sigh' Keynes then concludes that he has:

> (…) a feeling that Prof. Tinbergen may agree with him, but that his reaction will be to engage another ten computers and drown his sorrow in arithmetic. (Keynes, 1939, p. 568).

Because of the complexity of economic reality, and because of the uncertainty that results from such complexity, the use of mathematical models is highly limited according to Keynes. Like Marshall and Hayek, Keynes believed that due to this complexity, mathematical models always rested on (implicit) a priori assumptions (such as *ceteris paribus*). The more of these assumptions are involved, the more incomplete and less like reality a model becomes. This was one of the main problems that Keynes noticed in the output of mathematical economics of his time:

> Too large a proportion of recent 'mathematical' economics are mere concoctions, as imprecise as the initial assumptions they rest on, which allow the author to lose sight of the complexities and interdependencies of the real world in a maze of pretentious and unhelpful symbols. (Keynes 1936, p. 298)

Mathematics was, according to Keynes, at best only a small part of the economic discipline. For him, capturing, understanding and interpreting complex economic reality also involved:

> (…) the amalgam of logic and intuition and the wide knowledge of facts, most of which are not precise. (Keynes, 1972, p. 158)

What I have tried to make clear in the above is that the rise of mathematics in economics was not without criticism. Furthermore I have attempted to show that behind several of these criticisms voiced by important and influential economists lies the idea that economic reality cannot be captured in mathematical models or formulas, due to its complexity and openness.

Over time many more of such concerns have been voiced (Blaug, 2002). Amongst those voicing these concerns were, again, very influential economists such as Nobel laureates Milton Friedman and Paul Krugman who expressed their unhappiness with the fact that economics was becoming more and more a branch of mathematics than a social science dealing with real world economic problems. In spite of all these concerns however, economics has developed to become a thoroughly mathematical science (Lawson, 1997, 2012; Chick, 1998, 2001; Blaug, 2002; Marchionatti, 2004; Hodgson, 2013). Why is it that these concerns have not made their way into mainstream economics? Why is it that, in the words of Ronald Coase, "mathematics rides triumphant in economics?" (Coase, 1972, p. 415). I now turn towards a possible answer.

Complexity marginalized: the desire for prediction

The desire of economics to be like physics not only directed its approach to modeling but also elevated prediction as the supreme goal of the economic discipline. This predilection for prediction still exists today, as is evidenced by the continuous subscription of the economic science to Milton Friedman's famous argument that the test of a theory is its capacity for prediction (Hodgson, 2013, p. 14). It is the desire for the ability to predict that, I would argue, is the crucial force behind the marginalization of the calls for caution made by economists such as Marshall, Hayek and Keynes.

But first I want to take a closer look at where this desire for predictive power might come from. Why was it the ultimate goal in physics and what can this tell us about the goal of prediction in economics? Why did economics take over physics' goal, rather than only its methods? These are of course very big questions, and no doubt many different factors are in play. In this section, I want to expand on one factor in particular, which I claim to be of great importance. This factor is a development that Max Weber (1922, p. 117) has termed 'disenchantment' and that Charles Taylor (2007) has more broadly called 'secularization'.

In his 1922 *Science as a Vocation* lecture, Max Weber noted something similar to what Hayek and Keynes expressed about economics at their time:

> Nowadays in circles of youth there is a widespread notion that science has become a problem in calculation, fabricated in laboratories or statistical filing systems just as 'in a factory,' a calculation involving only the cool intellect and not one's 'heart and soul. (Weber, 1958, p. 113)

This idea that anything can be calculated is what Weber termed 'rationalization' and it is a crucial element of the process of 'disenchantment'. It is the idea that:

> (…) principally there are no mysterious incalculable forces that come into play, but rather that one can, in principle, master all things by calculation. (Weber, 1922, p. 117)

The phrasing "master all things" is crucial here. 'Disenchantment', or what Taylor calls 'secularization' is the process of men taking over from God the control of the world. It is the process of the marginalization of God in the natural world in the 19th and early 20th century (Taylor, 2007, pp. 94-95). Slowly, things that were normally assumed to be determined by God or other spirits came under men's control. Industrialization and the technological innovations that came with this process provided society with the idea that we can control nature and shape our own world. Furthermore it provided us with the tools to do so. Secularization moved the privilege to alter and direct the world from the domain of God to the domain of human beings (Taylor, 2007, pp. 121-125).

The crucial tool in bringing the world under the control of men was natural science (Taylor, 2007). For natural science provided not only the ability to explain what had happened but also to predict what would happen. And this ability to predict is the crucial element in men's ability to control and direct the world they inhabit (Taylor, 2007). We cannot control what 'way we will go', or what will happen, if we cannot predict the consequences of our actions. Without prediction, the world is out of our control.

And so the development of the natural sciences and its increased ability to predict natural events provided men with an increasing amount of control over the natural world and enabled them more and more to direct the natural world in the direction that they wanted it to go.

But the natural world is not the only world that mankind inhabits. For next to that natural world we also live in a world of social processes. I argue that the desire for control extends to that social world just as it did to the natural world and thus claim that the desire for predictive power in economics is the result of this broader development of mankind trying to gain control over the world they inhabit; the result of the desire to remove all mystical forces from that world.

In order to gain control over economic reality, we need to be able to predict. It is prediction that is required for economic policy, rather than explanation. If we cannot predict, it makes no sense to try and change the social world, for we do not know what the consequences of our actions will be. And it is in that respect also not very surprising that we turned to physics. For physics had proven itself to be extremely capable in predicting and at the time that economists turned to physics, men had already achieved a large degree of control over the natural world. So I would argue that physics-envy, or 'scientism' in Hayek's words, not only results from an admiration for its rigor and form, but also very much from an admiration for its ability to bring the world we live in under our control.

My claim is thus that the desire for predictive power in economics is an expression of man's attempt to remove all mysterious and mystical forces, such as invisible hands, from the social world, and to master all things by calculation. But it is precisely those mystical forces, those things beyond calculation that Marshall, Hayek and Keynes introduce, though in a different form, with their emphasis on the complexity of economic reality. Like Daniel Stein says:

> Complexity is almost a theological concept; many people talk about it, but nobody knows what 'it' really is. (Stein, 1989, p. xiii)

A complex reality is coherent in some recognizable way but it has a structure admitting surprise and novelty, which cannot be known beforehand. The problems of such real world complexity are thus, according to Hayek:

> (…) not, as one might at first suspect, difficulties about formulating theories for the explanation of the observed events - although they cause also special difficulties about testing proposed explanations and therefore about eliminating bad theories. They are due to the chief problem, which arises when we apply our theories to any particular situation in the real world. A theory of essentially complex phenomena must (unlike physics) refer to a *large* number of particular facts; and to derive a prediction from it, or to test it, we have to ascertain all these particular facts. (Hayek, 1989, p. 6).

And to ascertain all these particular facts is, for complex situations, virtually impossible (Kilpatrick, 2001). So precisely because the economic world is too complex to be captured by mathematics and to be predictable, it is also too complex to be fully brought under men's control.

There is thus a tension between real world complexity and prediction in the social sciences. In a complex world the possibilities for prediction are at best limited (Hodgson, 2013). This, I argue, is one of the main reasons for the marginalization of the pleas for caution by Marshall, Hayek and Keynes. Their emphasis on complexity was something that did not correspond to the desire to predict and control; it did not fit with the process of the disenchantment of the social world. In a complex world, where men has no control over what will happen, what basis is there for economic policy? It has been argued that this is also the idea behind Hayek's promotion of the adoption of laissez-faire economics (Kilpatrick, 2001). In any case it seems that subscribing to the idea of a complex economic reality highly limits the ability to say anything more about the future than that it is unpredictable. The line of thought that holds that mathematics is able to capture economic reality, and thus is able to determine the outcomes of economic events by calculation, has a much better fit with this general desire to take control of the world we live in. If we can calculate the outcomes of different actions and events in economic reality, we have a basis for policy-making, a basis for manipulating the world to make it fit the way we think it should be. This is something we had achieved in the natural world, and we desired the same thing for the social world we inhabit. Complexity, on the other hand, requires us to admit and, more importantly, to accept, that there are still 'mystical and mysterious' forces left in that social world: forces which are unpredictable and whose rationalization lies beyond our cognitive capacities.

That the victory of mathematical economics was the result of a predilection for prediction and control rather than one for mathematical rigor and beauty is something that is supported further by the fact that there have also been several alternative mathematical approaches which were able to deal with complexity, but that have been neglected by mainstream economic theory (Hodgson, 2013, p. 14). These alternatives (such as chaos theory or complexity theory) are able to capture complex systems in mathematics, but do so with a significant loss of predictive power. And so the marginalization of these approaches suggests that mainstream economics is not focused on mathematical models in general, but rather more specifically on mathematical models that yield predictions (Hodgson, 2013, pp. 14-15). A possible explanation for this desire for predictive power is thus, as I have argued above, the disenchantment of the social world.

Conclusion

In this paper I have argued that the development of economics towards the mathematical science that it is today has not been without critique. I have discussed concerns voiced by Alfred Marshall, Friedrich Hayek and John Maynard Keynes, which stress the importance of recognizing the fact that economic reality is highly complex and that this constitutes some serious limits to the use of mathematics in economics and to the predictability of economic reality in general.

Even though influential and important economists voiced these concerns, they have had virtually no impact on the development of the economic discipline as it exists today. The reason for this, I have argued, is that there is a tension between prediction and complexity. In a complex system the possibilities for prediction are highly limited at best. I have argued that there existed however a demand for predictive power that might be a result of the process that Weber has called 'disenchantment' involving men's attempt to gain control over the natural world they live in. I suggest that this desire to gain control exists for the social world just as it does for the natural world. In order to control, we need to be able to predict, and therefore the desire of men to have control over the world has been an important source of the demand for prediction. The conflict between this demand for prediction a complexity is the main reason behind the fact that the concerns voiced by economists such as Marshall, Hayek and Keynes, have remained in the margins and have not been able to affect mainstream economics. What I have tried to show in this paper is how it was possible that economics became a mathematical science *in spite of* the concerns that were raised against these developments by influential economists. This is so because the basis from which they criticized mathematics, real world complexity, was in conflict with the fundamental process of disenchantment.

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Notes

1. In this paper, mathematics is supposed to refer to the kind of formal tools used by the majority of the economic profession, which includes calculus and optimization, set theory, linear algebra and game theory.

2. Hayek believed that any restrictions on freedom to conduct trade, on price levels or on quantities sold would have serious negative consequences for welfare. The most efficient tool to improve the general level of wealth, he claimed, is competition of private actors in a free market. Keynes on the other hand believed that such a system often leads to macroeconomic outcomes that are inefficient. He thus argued for the occasional active policy intervention by the public sector, especially by monetary and fiscal instruments.

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