From Foundational Critique to Fictitious Players:
the Curious Odyssey of Oskar Morgenstern

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Introduction

For the contemporary economist, the names of von Neumann and Morgenstern are so tightly associated together that it is difficult to prise them apart. By virtue of their association with the creation of game theory, the two have become somehow "fused" together and the extraordinary differences between them lost to view. In what follows, I would like to consider the life and work of Oskar Morgenstern in particular, paying special emphasis to questions of foundational critique, both in his Vienna and early Princeton phases. This will also allow us to appreciate his distinct character and outlook, and the very great distance he travelled in drawing close to von Neumann.

From the mid-Twenties until 1938, Morgenstern was active in a Vienna bristling with intellectual activity and political tensions. Lapsed Austrian economist, Othmar Spann, preached a form of Romantic idealism, intentionally whipping up his students against rationalist economics, against Marxism, against Freud. Students who participated in Ludwig von Mises' seminar encountered in him a resolute attachment to political liberalism; strong views on the nature, potentialities and limits of economic theory; and scepticism concerning the potential role of mathematics in providing theoretical insight. Those who congregated around Hans Mayer encountered an Austrianism that sought to define itself, not so much by political vision as in critical confrontation with the formal work of Jevons, Cournot and Walras, with special emphasis on their treatment of time. Amongst the members of the Vienna Circle, Otto Neurath focused on poverty, needs and harsh realities, calling for the massive public organization of economic life, and conveying his views through rich visual displays at the Social and Economic Museum of Vienna.

Oskar Morgenstern came of age and shaped his professional identity amidst this richness. While, for most of the 1930's, he was director of the Austrian Institute for Business Cycle Research, with many public involvements, his role as critic of economic theory was fundamentally important to him. These were the writings that engaged him most and connected him to the broader academic world. Throughout the 1930's, Morgenstern sought to "modernize" economics, clearing aside what he regarded as the "rubble" of traditional wisdom. When he moved to Princeton in 1938, later meeting John von

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Neumann, his disposition as critic of economic theory facilitated their relationship and their collaboration on the theory of games.

While, viewed in this synoptic manner, there appears to be a smooth harmony to Morgenstern's development as critic, a little digging reveals all sorts of complications and intricacies. Exploring them will be the subject of this paper. For the moment, I will mention three.

The first is that while the role of critic came naturally to Morgenstern as a product of the "Austrian" school, his engagement with foundationalist criticism in the 1930's carried him *away* from Austrianism. At the beginning, in the late 1920's, he was an "Austrian" economist in good standing, shaped by Hans Mayer and Ludwig von Mises, and counting among his peers, Hayek, Haberler, Strigl and Rosenstein-Rodan. His emphasis on the need to account for time, knowledge and expectations was very much part of the Austrian approach. By the mid-1930's, however, while he maintained this critical stance, he was distancing himself from his Viennese contemporaries, insisting in his writings upon the heterogeneity of the Austrian School, and, virtually unique his economist peers, allying himself with several mathematicians with a view to correcting theoretical weaknesses in economics. By the time he left Vienna in 1938, while he remained typically Austrian in his critical stance, e.g., towards Walrasian general equilibrium theory, he had broken with Vienna, both literally and figuratively, and was something of a intellectual maverick in search of a new home.

The second observation concerns the complicated role that foundationalist criticism played in his collaboration with von Neumann. While Morgenstern's ideas here were essential in forming the bond between him and von Neumann, and in having him write an introduction to the Theory of Games, they do not appear to have been essential to the bulk of what von Neumann himself did in creating game theory. Related to this, and thirdly, with von Neumann, Morgenstern now found himself, for the first time, caught up in a mathematical maelstrom. Von Neumann, the Modern mathematician, drew him into a world that involved granting great autonomy to the mathematics, concocting empirical heuristics in order to justify mathematical results obtained by deduction, inventing purely formal devices such as the "ficitious player" in order to be able to extend the apparatus of the stable set to non zero-sum games. With this, not only was Morgenstern severed completely from Austrianism, but he was forced to re-evaluate, and distance himself from, some of his earlier critical work.[1]

The Economist as Critic

As I re-read the interwar articles, letters and diaries of Oskar Morgenstern in preparation for this meeting, I was struck by not only the centrality of critique to his theoretical activity in Vienna, but also the sheer doggedness he displayed in the matter. Whether confronting the sceptical responses of Hayek or Knight to his work, or being gently

[1] Let me note straightaway that what follows is neither complete nor fully thought out. It is intended, above all, to provide a basis for discussion.

castigated by kinder correspondents such as Eve Burns, Morgenstern showed himself to be consistently stubborn. For example, having been chided by Burns for his nihilism, he retorted:

> "I am very sorry to have disappointed you with my book [The Limits of Economics, 1934], due to its negativism, but I have the feeling that what is really necessary today is pitiless criticism, and I can tell you in confidence that I have only just begun. My second book will also be overwhelmingly critical. Because only through that can the rubble of traditional wisdom be put aside. And the way is free for new [ideas] . . . and modernization" (OM to Burns, March 6, 1934, OMDU)

While Morgenstern during the Thirties was a policy economist and research director of considerable influence, the writings for which he is best remembered, and which he seems to have regarded as quite important, were those concerned with theoretical critique. He wrote about business cycle theory: from what he regarded as its inevitable inability to provide useful prediction to its inadequacy in accounting for the passage of time. He also wrote about the imprecision in the treatment of the foresight of economic agents in contemporary neoclassical and general equilibrium theory. Throughout, he insisted on the need for greater logical rigour in economics in general.

His intellectual style here was a reflection of two distinct, and in some ways opposed, influences, and a great deal of the tension pervading Morgenstern's oeuvre can probably be understood in the terms of this opposition. The first was his "Austrian" inheritance, with the work of Othmar Spann, Hans Mayer and Ludwig von Mises all being influential.[2] Particularly important, it seems to me, was Mayer's Austrian critique of the inadequacy of orthodox theory in accounting for time, and Mises' emphasis on theory in opposition to German Historicism and American Institutionalism. The second set of influences was the mathematicians and philosophers with whom Morgenstern early cultivated a relationship. Morgenstern differed from his Austrian teachers in the openness he showed to developments in mathematics and scientific philosophy. His contact with various mathematicians, including Karl Menger and Abraham Wald, and his reading of other mathematicians and philosophers, including Carnap, Schlick, Russell and Hilbert, meant that he orientated his Austrian theoretical critique in a direction quite different from most of his economist peers.

Morgenstern's engagement with mathematics was a complicated matter. In Vienna, it became shot through with considerations of power. By allying himself with the mathematicians, he distinguished himself from his economist mentors and asserted his professional independence. His emphasis on clarity and rigour also allowed him to cleave a separation between the realms of economic analysis and politics: for he saw the

[2] I write "Austrian" here to signify the heterogeneity it implied: although Mayer and Mises regarded themselves as members of the Austrian School, their critical contributions of differed in many ways. As for Spann, he was far removed from Austrianism, describing the evolution of society in terms of a holistic, dialectical teleology.

field of economics as infiltrated with, and distorted by, the political preferences of theorists. He was explicit about this with regard to Mises, and there are hints that he regarded Keynesian policy as being based on sloppy theoretical foundations. There is also the fact that Morgenstern was himself ill-trained in mathematics, relying for guidance on seminars with Menger, tutorials with Wald and Franz Alt, and private reading. All of this made for a psychologically interesting situation, with Morgenstern showing, in papers that were often less than rigorously clear, a Lady-Macbeth-like obsession with clarity, purity and rigour.

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In 1925, Oskar Morgenstern had finished his doctoral degree, with a thesis on marginal utility, and was about to leave Vienna for three years on a Laura Spelman Rockefeller Fellowship.[3] Up to that point, he had been subject to several local influences, ranging from the holistic doctrines of "lapsed Austrian" Othmar Spann to the theoretical critique of his teacher Hans Mayer.[4] A one-time disciple of Carl Menger, and successor to Böhm-Bawerk's chair at the university, Spann had abandoned the methodological individualism of Austrian economics and developed what he termed Universalism. This admixture of German Romanticism and Idealistic philosophy took the social whole, not the individual, as the point of departure in understanding social evolution. Only when individuals adopted the role for which they were destined by nature could social harmony be ensured. Spann's corporatist outlook was essentially a neo-feudal one, inspired by the early 19th century writings of German Romantic Adam Müller and inflected by the mysticism of Novalis and Augustine. As far as I can determine, Spann left no lasting traces in Morgenstern's later work, but he was significant for at least two reasons. First, his work is a reminder that, in the mid-1920's, Morgenstern's eventual commitment to an economics based upon a foundation of methodological individualism was not a foregone conclusion. The Austrian economics of Menger, Wieser and Bohm-Bawerk was just one of a number of competing forms of socio-economic analysis, the others ranging from Spann's holism through Austro-Marxism to Bolshevism. Second, it is not impossible that Morgenstern's experience with Spann, in which infatuation was quickly followed by rupture, marked the beginning of the young economist's suspicion of any incursion of politics into social science. The theme of normative "purity", the search for an economics unbesmirched by political tastes, would become central to Morgenstern's work in the next decade.

If Spann's writings concerned social scientific foundations in the very broad sense, the second formative influence upon Morgenstern squarely confronted foundational issues in economic theory. As successor to Wieser at the University of Vienna as of 1923, Hans Mayer was an important presence, running his own seminar, becoming the first editor of

[3] It appears that no trace of Morgenstern's thesis is to be found in the archives.
[4] For a closer discussion of the early influences on Morgenstern, see Leonard (2004).

the *Zeitschrift für Nationalökonomie*, a position later assumed by Morgenstern, and then President of the *Nationalökonomische Gesellschaft*, when that society was recreated in 1928. Mayer's foundational critique of the 1920's culminated in his substantial 1932 paper, "The Cognitive Value of Functional Theories of Price", which focused upon certain incongruities in mathematical economics, in particular its inability to deal with *time*.

A worthy economic theory, said Mayer, one that was in keeping with the scientific ambitions of Carl Menger, would acknowledge that tastes emerged in time. Rather than taking preferences as given, present from the outset of the analysis, as did the theories of Cournot, Jevons and Walras, an appropriate theory would recognize the fact that some tastes were actually finite and that new ones appeared only when others were satisfied. Any theory that proposed to explain not just the existence but the appearance and evolution of prices had to take account of the temporal nature of preferences. By presuming that all tastes were present from the beginning, Walrasian general equilibrium theory excluded time from its framework, providing an artificially static portrait of a situation that was inherently temporal in nature. According to Mayer, such a theory was merely *functional*, not genetic-causal.

Mayer's detailed essay expressed the interwar Austrian resistance to the mathematical economics being promoted abroad in Lausanne and England. Similar sentiments were to be found in the work of Ludwig von Mises, particularly in his 1933 collection of essays, Epistemological Problems in Economics. The structures of mathematical economics, said Mises, in their rigidity and their focus on equilibrium, portrayed economic activity in unduly static, stilted terms. Economic life was fluid and ever-changing, and no mathematical treatment could adequately capture this.[5]

The critique advanced by Mayer and Mises also highlighted the limitations of Austrian theory. While it was relatively easy to insist upon the need for a theory that would recognize time, change, and the *tendency* towards equilibrium rather than its attainment, it was not at all obvious how to accomplish this. As long as no alternative theory was forthcoming, the constructive element in Austrianism would be overshadowed by its critical negativism.

While, for various personal and political reasons, Oskar Morgenstern would rarely acknowledge the extent to which he inherited the critical mantle of Mayer and Mises, it shaped him, and resonated in his essays of the 1930's. Where he differed significantly

[5] While Mayer's and von Mises' critiques of equilibrium economics shared common features, there was so much antipathy between the two individuals that any form of cooperation was impossible. The hostility seems to have been related to professional jealousy, with Mises having been denied a chair at the University of Vienna. It was further compounded when Mayer was complicit in the dismissal of Jews from the Economic Society in 1938. This would cast Mayer into the historical shadows for a good two generations.

from both was in his readiness to engage with mathematics and logic: if his teachers criticized formalism and turned away, he criticized it and tried to engage with it.

Wirtschaftsprognose

His 1928 Habilitation thesis, *Wirtschaftsprognose*, or "Economic Prediction, was written after three years of study abroad. Most significant for that essay was the year spent in the U.S., first at Columbia University, close to Wesley Mitchell and Henry Moore, and then at Harvard, with Charles Bullock and Warren Persons. Pointing to the significant forecast errors of the 1920's, Morgenstern advances theoretical arguments against the very possibility of economic prediction, such as that then being conducted by agencies such as the Harvard Economic Service, the Babson Statistical Organization and Moody's Investor Service.

The central idea is that, because economic actors react to forecasts, the latter will always be undermined. This undermining can be mild, such as when the effect of agents' reaction is to accelerate in time realization of the predicted phenomenon (e.g. a prediction of price rises), or severe, when the reactions of agents have the effect of reversing, or annulling, the prediction completely.

Morgenstern's argument is very "Austrian" in style, and is replete with foundational considerations. In the "static economy" of general equilibrium, economic choice and action no longer have any meaning: "the rationality of economic acts has reached such a high degree of perfection that the economic acts have disappeared" (1928, p.7). Everything stands still. The supposedly dynamic general equilibrium model of H. L. Moore is not fundamentally different, says Morgenstern, insofar as actors are presumed to know the "coefficients of movement" of the economy, thereby preserving "perfect subjective rationality" (ibid).

In the real economy, however, there is great heterogeneity. Economic subjects and entrepreneurs each have a set of "orientation points", which comprises the knowledge, beliefs and expectations that they use to make their way through economic life. The knowledge, beliefs and expectations of different individuals are closely related insofar as the behaviour of each actor affects that of others. When a prediction is made, each actor and entrepreneur must integrate it into his knowledge set and change his behaviour accordingly. How he changes his behaviour will depend on how he believes others to have assimilated the prediction and decided to change *their* behaviour.

In the relatively simple case of a predicted rise in the price level, the effect will be to induce agents to act in a manner the effect of which is to accelerate the predicted price increase, viz., buyers purchasing now rather than later; sellers holding stocks in anticipation of the rise. A prediction that doesn't apply to the time period for which it was intended, say Morgenstern, is a useless prediction.

Might the authority attempt to revise its prediction in order to pre-empt the reaction of the public? The effect would be to cause confusion among the public, with subjects and entrepreneurs postponing action until their knowledge and expectations had been

stabilised. Such a situation, in which the public and the authority each try to divine the actions and reactions of the other, Morgenstern likens to the famous anecdote from Sherlock Holmes, in which Moriarty is pursuing Holmes who has just left on a train from London to Dover. What Moriarty should do depends on whether he believes Holmes will go all the way to Dover or will descend at the sole intermediate stop. And what Holmes will do to evade him will depend on his estimation of Moriarty's likely action. The result is an infinite regress of guess and counter-guess, with no obvious issue.

In more realistic situations, where several agencies are making competing predictions, the way in which the public assimilates them, and thereby contributes to undermining them, will depend on a range of factors that no economic science can hope to comprehend, e.g., differences as regards optimism and pessimism; varying capacities of assimilation of economic information; and differing beliefs about the prejudices underlying the forecasts of the different agencies. So great is the number of individuals involved, and so great their heterogeneity, says Morgenstern, that it is impossible to comprehend the fate of a particular prediction beyond the moment it is announced. Agencies should thus confine themselves to presenting economic information, and cease making false claims about the efficiency of their mathematical methods in predicting the future.

With *Wirtschaftsprognose*, Morgenstern set the tone and, to a certain extent, the content of his theoretical writings in the decade that followed. Emphasizing heterogeneity and complexity in economic life, he would amplify his criticism of the standard "static" theory. In the absence of coherent, logical foundations, he argued, the very idea of equilibrium stood in jeopardy. Unlike the 1928 essay, however, Morgenstern's writings of the 1930's reflect significant changes that had occurred in his life in the interim. Firstly, as research manager, prominent citizen and, soon, journal editor, his world expanded. Already disinclined psychologically to be part of any particular "school", Morgenstern was now in correspondence with Knight, Keynes and others of similar standing, circumstances which saw him draw away even further from his Austrian economist peers. Secondly, for reasons themselves not unconnected to politics, he drew closer to the world of logic and mathematics: this saw him develop an increasingly non-Austrian response his Austrian foundationalist critique.

Politics and Precision

In 1929, after a delay of a year caused by Spann's political wrangling, Morgenstern was appointed *Privatdozent* at the University of Vienna. That same year, he became co-director, with Hayek, of the Austrian Business Cycle Institute, which had been set up several years previously by Mises. In 1930, the centre received five years funding from the Rockefeller Foundation, and, a year later, Hayek left Vienna for the London School of Economics, leaving Morgenstern in charge of the Institute. For the next eight years, he ran the Institute, overseeing its publication of economic reports and monographs, participating in various committees, and attending several scientific meetings or seminars, including the Economic Association, frequently; Karl Menger's Mathematical Colloquium, occasionally; and, at least once, the *Schlick Kreis*, or Vienna Circle. He

wrote his theoretical/philosophical contributions in the context of this broad, multifarious activity.

If, in the public sphere, he had to show professionalism and diplomacy, in his private ruminations, Morgenstern tended to be candid:

> "Friday was the Economics Association. Mises spoke about worn-out methodology, and his concluding talk especially was just impossible. Lots of Jews. Alvin Hansen is here, quite nice, but didn't impress me too much" (Diary, March 25, 1929).

While there is no evidence that Morgenstern's anti-semitism, then typical of many Austrians, had any concrete impact upon his intellectual life, it is manifest in his diaries, especially through the early Thirties. As collaborator of Abraham Wald and John von Neumann, he would learn to outgrow it. As for the division hinted at with Mises, while it seems to have had nothing to do with prejudice, it would only grow with time. In the course of the 1930's, Morgenstern learned to reject much of what he associated with Mises: his imprecision; his attachment to "a priorism" in economic philosophy; his idiosyncratic dismissal of the use of mathematics in economics; and his seeming inability to separate economic analysis from the promotion of "laissez-faire". As a result of his growing immersion in the world of logic and mathematics, Morgenstern increasingly insisted on precision and the evacuation from economics of normative or political preferences.

The beginning of his "break" with Austrianism may be found in his 1934 book, *Die Grenzen der Wirtschaftpolitik*, translated in 1937 as The Limits of Economics. Announcing it to Hayek, he wrote that he was "just finishing a little book that deals with the problem of adapting economics to problems in the economy. In many ways, I was inspired by reading Robbins' book, but it is mainly a summary of discussions I had with practitioners. It is particularly for a wider audience, and won't go much into methodological details" (OM to Hayek, July 11, 1933). In his diary, however, he was more frank: "I can already imagine what kind of echo the book is going to have. Lots of people are going to be in a huff, because somehow everybody is going to feel affected. But that's the way it is" (Diary, Sept. 17, 1933).

Subsequently dismissed by Hayek as "a collection of, often brilliant, aphorisms, but [lacking] the consistent argumentation with which one can start a discussion"[6], Limits is Morgenstern's attempt to insist upon the native "purity" of economic science: theory is completely separate from political stances such as liberalism, socialism or collectivism. At significant points throughout the book, Mises is clearly the target. Thus, "a priorism", Mises' view that the essential insights of economics are immediately obvious truths, not

[6] Hayek to Morgenstern, April 2, 1934.

requiring empirical verification, is dismissed by Morgenstern as a claim that can be neither confirmed nor refuted. A priorism has nothing to do with the real world, he says.[7]

Morgenstern similarly rejects all attempts to ground the defence of capitalism in economic science -- a feature of Mises' writings throughout the 1920's and reiterated in his 1933 collection, Epistemological Problems of Economics. Political preferences are the reflection of feelings and tastes, says Morgenstern, and, as such, cannot find support in economic analysis. Liberalism, he continues, argues against interventionism, yet remains silent about the intervention required in order to maintain free competition (p. 20). Liberalism has always looked to the classical economics of Smith and Ricardo, he says, thereby ignoring changes in economics that have occurred in the interim. Similarly, there may be changes in *mentality*, such as the growth of a popular desire for public provision; something that rigid "systems", such as liberalism, tend to ignore. This is *not* to say that economic theory is no longer capable of providing an explanatory framework, he adds, or that the historical method need be resurrected. It is, however, a reminder that liberal proponents of the *a priori* method are wrong when they "see in every appeal to experience and reality the ghost of the negation of theoretical, i.e., scientific, work" (p. 28).

In keeping with what he had previously advanced in *Wirtschaftsprognose*, Morgenstern maintains, in Limits, his nihilistic insistence upon complexity, difficulty, frictions and disequilibrium, all of which are ultimately related to the "time" factor. Thus, he says, analysing the effects of economic policy measures is made difficult by the fact that the immediately visible effects of a policy have a greater psychological impact than dispersed ones. The economy, furthermore, may not be in equilibrium to begin with. Elsewhere, (Chapter VI), he insists upon the need to analyze the effect of "power" in economic life. Böhm-Bawerk, in his *Macht und ökonomisches Gesetz*, had shown how the use of economic power through, for example, unionization, led to increased indeterminacy, but time, says Morgenstern, tends to weaken the effect of power. There is need for greater analysis of power, he concludes.

His chapter on "The Dangers of Economics" gives a sense of the way in which his thinking in the early 1930's was being shaped by diverse influences. One of the dangers arising from attempts to apply economics, he says, is that it is incomplete as a science. Only an *a priori* science (which economics is not), deductively worked through completely by a supermind, could theoretically hope for completeness. But not even in logic has this occurred. Here, he refers to a recent lecture by Karl Menger on "The New Logic", in which Menger outlined recent developments in logic, such as Russell and Whitehead's response to antinomies of set theory and Gödel's proofs concerning incompleteness. If logic is far from complete, says Morgenstern, then how much more incomplete must be the empirical science of economics.

[7] In an appendix to the 1937 translation, Morgenstern explicitly mentions Mises' a priorism as "one of the points where he diverges fundamentally from the view point put forward in the foregoing chapters" (1937, p. 156).

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> "In the evenings, I read Carnap, which is very difficult, but from which I gain a lot. I am slowly learning to think, and by doing that I come more and more into a mathematical way of thinking, or command myself into it"
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> Diary, March 30, 1929

Signs of Morgenstern's interest in analytical philosophy and mathematics were evident during his years as Rockefeller Fellow. During his time in Boston, he was a frequent participant at Alfred Whitehead's "at-home", and in Italy, in 1928, he wrote in his diary about looking forward to hearing David Hilbert and Hermann Weyl speak at the International Congress of Mathematicians in Bologna. Upon returning to Vienna and settling down, he continued to read widely, including Carnap, Hilbert and Ackermann, and Frankel.[8]

At the same time, he cultivated his contacts with mathematicians in Vienna, the most important by far being Karl Menger, son of the founder of the Austrian School. There was a certain complementarity between Menger and Morgenstern. Although a mathematician by training, Menger was very well educated in economics, having edited in 1923 the second, posthumously published, edition of his father's *Grundsätze*. Like Morgenstern, he spent time abroad as a post-doctoral student, in his case at the University of Amsterdam in the company of Dutch intuitionist, L.E.J. Brouwer. When he returned to a post in geometry at the University of Vienna, Menger became occasionally involved in economist circles. Like Morgenstern, however, he was not a "club man", and, a somewhat difficult personality, he tended to remain at the margins. Thus, while he was initially close to the core members of the Vienna Circle -- which included his advisor, Hans Hahn; Moritz Schlick, whom he revered; Otto Neurath, whose radicalism he disliked; and Rudolf Carnap – Menger soon distanced himself from the group, choosing to describe himself as, not a member, but an associate of the Wiener Kreis. He may be seen as a querulous figure, an insider neither in the Circle nor among the economists.

Menger's influence upon Morgenstern was exerted in several ways. First of all, as Director of the Austrian Business Cycle Institute, the economist was in a position to offer financial support to impoverished mathematics students known to Menger. These included Abraham Wald, most famously, and Franz Alt, both of whom provided some combination of research work for the Institute or mathematics instruction for Morgenstern. The latter developed a close relationship with Wald, in particular, consulting him on his interpretation of Keynes' Treatise on Money and other critical writings. Second, Menger's own writings in economics and social science, and certain of

[8] For all that, Morgenstern never achieved any significant mastery of mathematics himself, remaining, above all, a critic keen to engage with mathematicians. It may have been that this "distance" from mathematics contributed to his effectiveness, allowing him to concentrate on the broader theoretical picture without becoming absorbed in the technical details.

his public lectures, such as the one on logic mentioned above, became required reading for Morgenstern. The key articles here included Menger's "St. Petersburg Paradox", "The New Logic", "Remarks on the Law of Diminishing Returns", his lecture on "Einige Neuere Fortschritte..." ("Recent Progress in the Exact Treatment of Social Scientific Problems"), and his 1934 book on mathematical sociology, Moral, Wille und Weltgestaltung.

Without going into each of these contributions in depth, we can mention several of their significant characteristics. Menger's paper on the St. Petersburg Paradox showed how various attempts to theoretically resolve that paradox had all failed. The paradox in question could be explained only by taking account of the fact that people differed in the manner in which they evaluated risk or future returns. His "Diminishing Returns" paper was a scathing critique of putative "proofs" of the Law of Diminishing Returns, including one by Mises. It deconstructed several such proofs, showing how their arguments were ill-conceived, their conclusions not following from their postulates. His "New Logic" lecture of 193 was an outline of the history of logic, with special emphasis on the paradoxes in set theory associated with Russell and the effect of the recent proofs by Gödel on the Hilbert Programme in metamathematics. Finally, his book of 1934 on sociology was an attempt to provide a logic of social compatibility, analysing the formation of groups without any normative stipulations whatsoever by Menger himself.

Underlying much of Menger's foray's into social science was the conviction that, in matters of logic and proof, many economists were less than rigorous. His outrage here amplified that of Morgenstern who, through his close association with someone who was both a true mathematician *and* son of the founder of the Austrian School, gained confidence in his own critical attitude. Thus, when Menger was in a position to challenge the looseness of Mises' arguments, or the inexactness of his references to logic and proof, Morgenstern was energized in his breaking away from this father figure.[9] When Hans Mayer refused to publish Menger's St. Petersburg Paradox analysis, because it was supposedly too mathematical, this contributed to the frustration felt by Morgenstern with this other mentor. All in all, Morgenstern's continued embrace of mathematics was bound up with considerations related to self-assertion and the creation of an independent identity.

Simulated by this new mathematical company, Morgenstern confronted foundational matters more directly than he had in Limits. Thus in early 1935 he wrote to Frank Knight: "I myself am very critical of orthodox views of the Vienna School. Have you read my article on "The Time-moment in Value Theory"? I would be interested in comments" (OM to Knight, January 4, 1935).

[9] Other considerations also appear to have affected his relationship with his former teachers, including a failed bid by a group, including Mises and Mayer, to gain Rockefeller funding for a research group in the social sciences, parallel to Morgenstern's Institute. By the end of 1934, the latter could write that Mises and Mayer were not going to be asked to the Institute anymore (Diary, Dec. 9, 1934). On this Rockefeller episode, see Leonard (Austroliberalism).

Inspired by Mayer's insistence on the centrality of time, and influenced by Morgenstern's reading of Schlick and Menger, that paper is, above all, a potted expression of dissatisfaction with the mechanical way in which time had thus far been integrated into general equilibrium analysis. Without offering any constructive alternative, Morgenstern criticizes the Walrasian for assuming infinitely fast adjustment of prices, suggesting the likelihood that speeds of adjustment differ across markets. He also dismisses H.L. Moore's introduction of a time coefficient into the Walrasian system to create a "moving equilibrium". Much of Morgenstern's dissatisfaction seems to stem from the fact that the effect of time is likely to be felt differently in different parts of the economy. For example, tastes can be expected to vary over time in an unpredictable and irregular manner. Lack of concrete suggestions notwithstanding, Morgenstern insists that these questions will be best tackled by mathematical means. He concludes:

> "From the management of time by the consumer and the entrepreneur, then, results a genuine inclusion of the time element in the theory of the exchange economy. Such an approach penetrates the problem much more then some introduction of time-parameters into some system of equations and the tagging of all economic processes with time indices. . . . The time element presents one of the most urgent problems with which economic theory is faced. About the immense difficulties there can be no doubt. For this reason the intensive collaboration of many investigators has become very necessary" (p. 167).

Frank Knight did not think much of this paper, saying that he found the whole argument to be "of such of a degree of refinement of conception and doctrine that [he] did not get the feeling of very great importance in the contribution" (Knight to OM, undated). Undeterred, Morgenstern pressed ahead with his critique of time and general equilibrium, penning his more successful "Perfect Foresight and Economic Equilibrium" of 1935. Not only did this paper gain the applause of correspondents such as Knight and Haberler, but it appears to have stimulated further work by Hayek, some features of which help illustrate Morgenstern's deviation from Austrianism as it was evolving along Mises-Hayek lines.

In this paper, Morgenstern criticizes Walras and Pareto for failing to be the degree of foresight assumed of agents in general equilibrium theory, and he levels particular criticism at Hicks for suggesting that such agents are endowed with "perfect foresight". Similarly, Keynes, in the Treatise on Money, refers to "correct forecasting" or "accurate forecasting". This, says Morgenstern, "need not absolutely coincide with complete foresight, although the accompanying text borders upon this interpretation" (p. 170). Morgenstern's central message is that, unless it is made clear what exactly agents are presumed to know – about price mechanisms, and the actions, knowledge and intentions of other agents – the conceptual underpinnings of general equilibrium are flawed. What is meant by "perfect foresight"?, he asks. If, as appears to be the case, it means complete knowledge of the economic process, then the knowledge and analytical powers presumed of the individual are simply extraordinary, for he has assimilated nothing less than a completed science of economics. It is not even clear that such agents, or "demi-gods",

could exercise such foresight, since planning future actions requires taking account of the actions of others. The attempt by each individual to refine his intended actions in response to his evaluation of the intended actions of others would lead to an infinite regress, in which no agent would have the last say. Here, Morgenstern resorts, once again, to the Holmes-Moriarty example in order to illustrate the intractability of such interactive outguessing.

Just as the Holmes-Moriarty episode had been used to illustrate the impossibility of economic prediction in *Wirtschaftsprognose*, here it is used to suggest the impossibility of general equilibrium, in the absence of greater clarification of what exactly is assumed of theoretical agents. It is worth emphasizing the nihilistic tone that pervades Morgenstern's account: "Unlimited foresight and economic equilibrium are ... irreconcilable with one another" (p. 174). Without a formal specification of states of knowledge and how they relate to one another through time, the very idea of general equilibrium is without foundation.

As usual, Morgenstern is vague as to what is to be done. His interest in paradoxes having been stimulated by his reading in set theory, he suggests that it might be possible to overcome outguessing paradoxes using something akin to Russell's theory of types. Knowledge about basic facts (prices, quantities) would be of the lowest type; knowledge about others' knowledge would be of a higher type; and so on. Such a gradation, he suggests vaguely, might be used to clarify the relationship between knowledge and equilibrium.

The other source to which Morgenstern points, and with greater assuredness, is the above-mentioned book on mathematical sociology by Karl Menger. The analytical core of his book explored the compatibility of theoretical agents who had different characteristics or had taken various stances with respect to simple social norms. Thus, for example, one's sensitivity to others, combined with one's decision to smoke or not, had logical implications for the formation of compatibility groups among the combined population of smokers and non-smokers. Menger's simple geometry of social interaction was seen by Morgenstern as the potential beginnings of a mathematics adequate to the analysis of interacting agents: "the only examination of a strictly formal nature about social groups. . . which, it is hoped, will become known to economists and to sociologists because of its importance in laying the foundation for further work" (pp. 174-5).[10]

Morgenstern's reaching out to Menger here unwittingly revealed the mere two degrees of separation that stood between his meditations on general equilibrium and the tumult of Viennese politics. For Menger had begun creating his formal sociology in 1933, when

[10] As for Morgenstern's "Logistics and the Social Sciences" of 1936, suffice it to say that it is essentially a repetition, for economists, of Menger's 1932 public lecture, "The New Logic". Only a formal approach to economics can overcome the pitfalls posed by the use of ordinary language. Menger's "logic of wants or wishes" is held up as a starting point for the logical analysis of economic wants (Op cit, p. 404).

political tensions between the clerical conservatives under Dollfuss and the socialists of Red Vienna became so unbearable as to force him to abandon his work in mathematics proper. He turned for solace to the formal analysis of social compatibility, and his examples of smokers and non-smokers were, in fact, slightly disguised explorations of social relationships more important to him, such as those between Left and Right, or Jews and Non-Jews.

There were, of course, significant differences between the theoretical difficulties of concern to Morgenstern and the simple analysis of Menger, the most important, perhaps, concerning the role of time. Menger's simple examples were entirely static: individuals took stances with regard to norms and this gave rise to various (logically) possible compatibility groups. Time played no role: there was no consideration of either evolution of attitudes or experience. Morgenstern's concern for the foresight and expectations of agents had originated in, and remained imbued with, considerations concerning the passage of time. However, with the benefit of hindsight, it could be said that, in reaching out to Menger's static structures, Morgenstern was unwittingly sowing the seed of a capitulation of sorts, in which his rich, and impossibly demanding, Austrian critique would be reined in and diminished in order to accomodate the limited possibilities offered by mathematics.

Such a reading is in keeping with another aspect of the story surrounding the "Perfect Foresight" paper. In early 1936, Hayek wrote to him from the LSE: "It will interest you that we recently had an interesting discussion about your essay in our seminar. Since I consider the results were really valuable and enlightening". Hayek went on to say that he was considering writing up the results of their seminar discussion for publication in the *Zeitschrift für Nationalökonomie*. (Hayek to OM, Feb. 9, 1936).

Coming from the same Austrian background, Hayek shared Morgenstern's interest in these questions of the relationship between time, foresight and economic equilibrium. Indeed, in his own paper, Morgenstern had quoted disapprovingly an earlier article by Hayek, in which the latter, perhaps referring to Hicks, had written:

> "It has become clear that in place of a simple negligence of the time-motive, well-defined assumptions must deal with the attitude of the persons concerned as regards the future. *Assumptions* of this kind, which the analysis of equilibrium must make, *are substantially that all persons concerned correctly foresee the relevant events in the future*, and this foresight has to include not only the change in objective data *but also the behaviour of all other persons*" (Hayek 1935, quoted in Morgenstern 1935, p.171, italics Morgenstern's).

The response by Hayek to Morgenstern took the form of, not a ZfN publication, but his famous "Economics and Knowledge" article of 1937, in *Economica*. Here, Hayek clarified his thinking on the matter of the relationship between anticipations and equilibrium. Unlike Morgenstern, who was prepared to jettison the notion of equilibrium in the absence of a rigorous description of the behavioural underpinnings, Hayek puts the emphasis on the obvious empirical fact of economic coordination and, only then, asks

what account of foresight would be congruent with it. The existence of equilibrium simply meant that the foresight of all agents was "correct", insofar as all plans were in harmony and based upon the same knowledge and expecations.

> "Correct foresight is then not, as it has sometimes been understood, a precondition which must exist in order that equilibrium may be arrived at. It is rather the defining characteristic of a state of equilibrium. Nor need foresight for this purpose be perfect in the sense that it need extend into the indefinite future, or that everybody must see everything correctly. We should rather say that equilibrium will last so long as the anticipations prove correct, and that they need to be correct only on those points which are relevant for the decisions of the individuals" (1937, pp. 41-42).

Hayek went on to downplay the importance of empirical investigation, concluding, somewhat ambiguously, that it was more important to be clear about the principles involved.

From here on, Morgenstern and Hayek would take quite different paths. Although both were Austrian critics of neoclassical orthodoxy and general equilibrium, in their responses, over the course of the interwar period, they diverged increasingly from one other. While Hayek developed his unique brand of social science, criticizing "scientism" in economics and promoting a liberal politics, Morgenstern embraced formal, mathematical work and became ever more suspicious of those, to the Left or the Right, who sought to make political use of economic analysis. By the time he had fallen under von Neumann's spell at Princeton, Morgenstern would become very dismissive indeed of Hayek.[11]

Keynes

During the 1930's in Vienna, the figure of Keynes is clearly important for Morgenstern, but he remains spectral, hovering in the background and never fully brought into the open. In May, 1934, in reference to the Treatise on Money, Morgenstern's friend Haberler wrote to him:

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[11] Thus, by 1942, Hayek's Pure Theory of Capital was "higher nonsense". Hayek keeps "talking about an "Investment Function", but there is no question of stating the concept with any precision. He does not seem to know what a function really is. This type of "economic theory" must vanish" (Diary, March 15, 1942). A year and a half later, "Yesterday a letter from Hayek. He hates science as he always has. He claims to have heard "many curious rumous" about the book. Funny. He is going to find it even more "curious" when he sees it. . . He is in a dead end. The Pure Theory of Capital is not worth reading" (Diary, September 1, 1943). "Reading Hayek's Serfdom. It's not worth a lot. Only wonderful in its love of freedom. He should look up what is said in our book about symmetry and fairness! There is nothing profound in it. Naturally I don't like planning either, but the intellectual situation is much more complicated" (Diary, Oct. 25, 1944).

> "I am convinced that you will find contradictions on every page of Keynes' book. The book is incredibly sloppily written. For instance, he always falls back onto the ordinary, same definition of saving and investment, and forgets his artificial definition, according to which losses . . . which one has never gotten are counted among the savings. As I hear, he is working on a new edition of the first part. I would wait with the criticism until it appears" (Haberler to OM, May 22, 1934).[12]

Morgenstern clearly drafted an article critical of the Treatise, but, thus far, I have been unable to find any trace of it. In September 1935, he wrote in his diary about finding his "long lost notes on Keynes":

> "I am going to have them copied and then go through them with Wald. I am still positive that is much more to be said about them than has been said up to now. For example, that (PI) should contain all prices, but P only consumption goods, P' investment goods. Where are the old ones, and the wages?! and many other absurdities. For example, his impossible definition of saving, which again is only the additional saving"
>
> Diary, September 9, 1935.

The following month, he wrote that Wald found his article on Keynes to be "mathematically alright", and that he was going to send it for publication "to Chicago".[13] To Knight, at the Journal of Political Economy, he announced the submission as an amended verion of his "Perfect Foresight" article, with added observations on risk. "I have a certain interest to have this article appear in English because Mr. Keynes is preparing a book on the theory of money based largely on the element of expectation and anticipation" (OM to Knight, Dec. 18, 1935). Not only was the proposal rendered nugatory by appearance of the General Theory, but Knight loved the "Perfect Foresight" article as it stood, describing it as "a major piece of work", and even translating it himself, releasing it as a Chicago mimeo.[14]

Among Morgenstern's correspondents, Keynes' book met with cursory abuse. "Have you read Keynes already?", wrote Haberler. "There are rather ghastly things in the book that a purely logical critic would, I believe, have a field day! For example, the story of the multiplier seems to me utter nonsense" (Haberler to OM, March 7, 1936). By April, the book had become "simply horrible". From Chicago, Knight wrote that, while he only begun reading it, "a couple of my friends whom I consider pretty competent judges say outright that Keynes is losing his mind" (Knigh to OM, May 1, 1936).

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[12] This was followed by another letter in which Haberler wrote "As my wife told me, you also believe now that your Keynes criticism is justified. I am looking forward to the new version" (Haberler to OM, July 11, 1934).

[13] Diary, Oct. 26, 1935

[14] Knight to OM, May 1, 1936.

In 1937, in an eight-page appendix added to that year's translation of *Wirtschaftsprognose*, Morgenstern connected his critique of "time" and "expectations" to the General Theory.

> "Mr. Keynes has given a prominent place to the role of expectations. But his analysis relating to this point is so vague that I think we shall have to wait for further elucidations from his pen before delivering final judgment on it. Obviously it is not sufficient merely to refer to expectations and anticipations. We need to know how they are determined, on what factors they depend and the ways in which they are mutually interdependent. Mr. Keynes gives no real analysis of these points" (p. 158-9).

By the time he was collaborating on the Theory of Games, Morgenstern would become as dismissive of Keynes as he had of Hayek, privately regarding him as a "scientific charlatan".[15]

Throughout the mid-Thirties, Morgenstern intended to collect these critical/theoretical articles in the form of a book, to be called "Time, Profit and Economic Equilibrium", and he was still considering it after he moved to Princeton in 1938. Then, he was deflected in this when he fell in with John von Neumann.

* * *

To Princeton

Having already done so elsewhere, I shall not discuss enter in detail into the collaboration in the years leading up to the Theory of Games. Rather, I would like to discuss the extent to which foundational criticism was important to that partnership, and the way in which that collaboration marked the death of Morgenstern as an "Austrian" economist.

Morgenstern and von Neumann met at a time when both were slightly vulnerable. The former had left Vienna in early 1938, just before the *Anschluss* of Austria and, with that, the takeover of his research Institute by Ernest Wagemann, director of the Berlin equivalent. While many Viennese intellectuals and academics, especially Jews, had begun leaving the city after 1933, Morgenstern had hung on till the end, enjoying influence as public economist, even with the anti-liberal Austrofascist regime from 1934 till 1938. Then, he found himself at Princeton, stripped of all such power and influence, and he had to invent himself anew. No longer being concerned with Austrian policy issues, he was free to concentrate on theory.

Von Neumann had been at Princeton – first the University and then the Institute for Advanced Study -- since the early 1930's, and was thoroughly settled in America. The late 1930's, however, was a particularly unsettling time for him. His first wife abandoned him in December 1937, so that von Neumann spent much of 1938 in Hungary

[15] See Diary, May 2, 1943.

and other European countries, trying to arrange the exodus of his future wife, Klara Dán. These personal difficulties were compounded by the turns being taken in Hungarian politics, with the institutionalization of anti-Semitism and consequent pressure on both his and his in-law's families. While both families did escape Hungary during this time, von Neumann's exiled father-in-law then committed suicide at Princeton in December 1939. All in all, this was an extremely difficult time for von Neumann and it had the effect of destroying his scientific output for two years.

This commotion, however, was also what brought him back to game theory. In the late 1930's, von Neumann had done essentially nothing in game theory since publishing the 1928 paper, in which he had proved the minimax theorem for the 2-person, zero-sum game and surmised, briefly, that larger games might be analysed in terms of the payoffs available to coalitions of players. Now, over ten years later, when confronted with political developments in Hungary and Europe, von Neumann was drawn towards the analysis of social and political alliances, in a manner not unreminiscent of Karl Menger in Vienna in 1933. That is why the Theory of Games is taken up with, above all, the analysis of equilibria in coalitional games, with a central, stabilizing role being played by social norms as regards discrimination towards certain players or groups.

In early 1940, therefore, Morgenstern, encountered the mathematician necessary to fill the gap after separating from his Viennese colleagues, and von Neumann an interlocutor open to his re-nascent theory. There were also significant emotional factors involved, with Morgenstern acting as buffer between the sometimes tense Hungarian couple. This intimacy meant that Morgenstern could be perfectly candid with von Neumann, including about what he knew and didn't know in science and mathematics. Together, Morgenstern and the von Neumann's were part of Princeton's *Mitteleuropa* community-in-exile, which included Einstein, Hermann Weyl, Carl Siegel, Gödel, and, on occasion, Thomas Mann. These years were dominated by what was happening back in wartime Europe.

Von Neumann's energizing presence can be felt in Morgenstern's harsh critique of Hicks' 1939 Value and Capital, a book he described as one of "the most unreadable works . . . on economic theory" (1941, p. 364).[16] Pointing to Wald's (1935) and von Neumann's (1937) proofs, Morgenstern dismisses Hicks' assumption that the counting of equations and unknowns is sufficient to guarantee the determinateness of a linear system. He also condemns the "indiscriminate use of the word "equilibrium". . . "If the respective equilibrium is not qualified further as being either stabile, labile or indifferent, the whole statement hangs in the air, adding to the usual vagueness of the usual procedure. . . Some of these equilibrium conditions need not at all conform to the ordinary simple maximums or minimums. They are most likely of the so-called "minimax" type, the analysis of which requires instruments of great subtlety" (pp. 374-5, footnote). In keeping with what we have seen earlier, Keynes is criticized for his imprecise treatment of expectations, and it is quite likely that it is to Hayek that Morgenstern is referring when he condemns the lack of clarity in the discussion of "consistency of plans" and equilibrium:

[16] For more detail, see Leonard (1995) and forthcoming.

> "It is obvious that . . . it has not been decided whether there exists only one single grouping of plans which is compatible with equilibrium or whether there are many possible ones, each of which would be "consistent". In order to decide a problem of this kind it is, naturally, necessary to be more specific about the character of the plans or, in other words, to define them more specifically. The problems involved are of quite exceptional difficulty and resemble closely those of the theory of games" (p. 380).

Throughout this phase, Morgenstern's thinking was dominated by what he called the "Prediction-Time Complex". In 1940, stimulated by these new discussions with the Hungarian, he began writing his "Quantitative Implications of Maxims of Behavior" (1941b), in which, albeit in a purely discursive manner, he attempts to extend the analysis of interacting decisions beyond what he had seen achieved in Menger (1934). Unlike the latter, he is particularly concerned with what he terms *restricted maxims*, i.e., maxims which cannot be executed regardless of how others behave with respect to them, such as drawing deposits from the bank. The individual's decision to act according to such a maxim will depend upon their evaluation of how others are likely to act, all of which places great demands upon the intelligence of the acting individuals" (op cit, p. 8).

Making the connection between this embryonic analysis and politics, Morgenstern argues that such situations highlight the potential for positive interventionism, in order to substitute for individual subjective rationality: for example, the imposition of a moratorium on bank withdrawals, in order to protect deposits, would accomplish what each individual would desire if they were in a position to take full account of the intended actions of other account holders. Such intervention, by providing a "substitute for the corrective which superior information and intelligence would offer", would not be vulnerable to the "criticisms which are voiced against every intervention by the adherents of a purely laisser-faire attittude" (p. 17). Once again, as in the Hicks essay, von Neumann's recent work on games is cited as a possible approach to such situations.

Entering von Neumann's Universe

While von Neumann read several of Morgenstern's Vienna papers, including "The Time Moment", and now the Hicks review and "Maxims", he independently extended his theory of games to situations of 3, 4, and more players. The result was what became the Theory of Games and Economic Behavior, a 630-page exploration of games of different size, with an elaborate introduction that was written by Morgenstern and corrected and amended by von Neumann.

Phil Mirowski has written about what he calls the two conflicting "voices" in the Theory of Games, the "other" voice being that of the Austrian economist concerned about time and dynamics. While I agree, and have suggested above, that the latter was a defining part of Morgenstern's background, my sense is that, come the publication of the TGEB, there was no conflict as such, because Morgenstern had, without the slightest degree of reluctance, made all the necessary concessions. By that, I mean that the closer he drew to

von Neumann, and to the realities of actual, mathematical creativity, the more he found himself tailoring his theoretical ambitions and rescinding his vestigial Austrianism.

Three vignettes from the TGEB allow us to explore various facets of the work in relationship to Morgenstern's foundational critique. I will consider the book's Introduction, its resolution of the Holmes-Moriarty dilemma, and von Neumann's sophisticated analysis of coalitional games.

The Introduction represents the meeting of the two minds, motivating the TGEB by reference to the lacunae of orthodox neoclassicism. Simple utility maximisation and Walrasian general equilibrium are rejected as the primitive, uninventive application of rational mechanics to the social domain. This comes from von Neumann who, as Phil Mirowski has pointed out, viewed the work of Hicks, and later Samuelson, with great disdain. The Austrians, of course, including Mayer, Mises and Hayek, would have agreed with the dismissal of mechanical general equilibrium, but for different reasons. It is thus a measure of the distance travelled by Morgenstern that he was now viewing the matter from von Neumann's perspective – without, of course, the latter's background or accumulated mathematical training. This, in turn, explains the numerous references in his diary to the deep transformation he was undergoing: learning, nay struggling, to see the world in a (appropriate) mathematical way. Related to this, the chapter also rejects the idea that there is any fundamental distinction between social and natural science, *Geisteswissenschaft* and *Naturwissenschaft*. This is certainly Morgenstern speaking, but he was only affirming now what he had begun thinking during the 1930's, at Menger's instigation.[17]

The reason why the mathematics of constrained utility maximisation was irrelevant was because it failed to address the fundamental conceptual starting points: decisions were very often dependent upon the evaluation, not of fixed constraints, but of the likely decisions of others. Hence, the similarity between social interactions and games, and, with that, the need for a new mathematics, crafted especially for the domain. Nor was it clear, they write, that the analysis of games of increasing numbers of players would automatically lead to a re-emergence of a coalition-free, perfectly competitive situation.

Behind this measured expression of doubt about the relevance of perfect competition lay von Neumann's gut conviction of the importance of multiple social equilibria: a single physical background could give rise to many different possible social structures. As I have argued elsewhere, this had been brought home to him through his confrontation with politics in the 1930's. The discussion of foundations, therefore, and thus the introductory chapter, came *after* the essential creative work had been sparked. It was a *post hoc* construction in which Morgenstern could join, essential in motivating, for the reader, the difficult theory that followed, yet of secondary importance to it from the point of view of

[17] In his "Neuere Fortschritte", Menger rejects this distinction, thereby distancing himself from the Austrian tradition inspired by his father. Elsewhere, he would write about the tussle between the "two souls within his breast" (Goethe): that of the mathematician and that of the Austrian economist.

scientific creativity. "One of these days", wrote Morgenstern on New Years' Day, 1943, "I have to write down a few things about the story of the book (and my minimal share; but I seem to have acted as a kind of catalytic factor)".

* * *

On pages 176-178, the Theory of Games resolves the Holmes-Moriarty dilemma, presenting it as a 2-person, zero-sum game and solving through the application of mixed strategies. It is assumed that, to Moriarty, catching Holmes is worth 100; missing him at the intermediate station worth -50 (since he gets all the way to the Dover port) worth -50; and missing him at Dover worth 0 (since he remains somewhere in the country and doesn't escape to the Continent). With these payoffs, Moriarty should go to Dover with a probability of 60%, and Holmes should get off at Canterbury with a probability of 60%.

In a footnote to this analysis, Morgenstern explains that he no longer holds the "pessimistic views" he expressed when he first cited this Holmes-Moriarty dilemma, in *Wirtschaftsprognose*, or in his "Perfect Foresight" article of 1934 (p. 176, n.2). Simple though it may be, this is a particularly "pregnant" footnote. For while the minimax analysis solves the decision-making task of Holmes and Moriarty, it offers little by way of response to the problems of prediction that originally motivated Morgenstern's use of the story in *Wirtschaftsprognose*. Recall that Morgenstern was concerned there with showing why complexity could only result in the defeat of an economic prediction. In particular, a government that tried to revise its prediction in order to anticipate the public reactions to its first forecast would cause so much disturbance amongst the multiplicity of economic agents that "the economic equilibrium would be disturbed profoundly" (*Wirtschaftsprognose*, p.98). All actions would stop and "economic subjects and entrepreneurs would wait for a stabilization of the system of orientation points which was shifted in an artificial way. All economic plans – and inentions are contined in the plan and its duration – would be postponed. Only misery and lightmindedness would govern" (*ibid*). That this nihilistic 1928 emphasis on confusion amongst multiple subjects is now being dismissed as unduly "pessimistic", is a measure of Morgenstern's evolution from Austrian critic in 1928 to analytical co-author fifteen years later.

Similarly, in "Perfect Foresight and Economic Equilibrium", the Holmes-Moriarty example was used to illustrate the difficulties raised by the assumption of perfect foresight in agents in general equilibrium. Under such an assumption, the individual has perfect foresight into all aspects of the economic process: prices, production, revenue. Given the extent to which all economic phenomena are interdependent, this logically implies incredible powers on the part of the economic agent:

> "The individual exercising foresight must thus not only know exactly the influence of his own transactions on prices but also the influence of every other individual, and of own future behaviour on that of the others . . .
> . . . The imposible high claims which are attributed to the intellectual efficiency of the economic subject immediately indicate that there are included in this

> equilibrium system nor ordinary men, but rather . . . demi-gods, in [the] case [where] the claim of complete foresight is fulfilled" (p. 173)

With its two players and two strategies, the Holmes-Moriarty situation once again represents a drastic simplification, this time of the general disequilibrium complexities emphasized by Morgenstern in "Perfect Foresight". Only having been swept away by von Neumann's knowledge and wizardry could he choose to emphasize the technical solution and dismiss as unduly pessimistic his critique of a decade earlier. Thus he could write:

> "I have the impression that my former scientific life was just full of vague presentiments. I have probably always expected a lot from mathematics and logic, but I was so mistrustful in some aspects, partially under the influence of K. Menger, and rightly so. Since I have known Johnny, everything has changed, and a completely new era has started for me. I am not at all sad that I haven't some (many!) papers, because they would mean nothing to me today" (Diary, December 5, 1943).

* * *

In mid-April, 1942, having watched von Neumann spend two hours constructing the axiomatics of cardinal utility, Morgenstern marvelled in his diary: "It gave me great satisfaction, and moved me so much that afterwards I could not think about anything else. I feel more and more the aesthetic pleasure linked with mathematics. I believe that this is one of the main characteristics" (Diary, April 14, 1942).

This emphasis upon aesthetics was very much von Neumann's, and he explained its place in his philosophy of mathematics in an essay, "The Mathematician", published in 1947. What did one look for in mathematical practice?, von Neumann asked:

> "Ease in stating the problem, great difficulty in getting hold of it and in all attempts at approaching it, then again some very surprising twist by the approach, or some part of the approach, becomes easy, etc. Also, if the deductions are lengthy, or complicated, there should be some general principle involved, which "explains" the complications and detours, reduces the apparent arbitrariness to a few simple guiding motivations etc. These criteria are clearly those of any creative art, and the existence of some underlying empirical, worldly motif in the background – often in a very remote background – overgrown by aestheticizing developments and followed into a multitude of labyrinthine variants – all this is much more aking to the atmosphere of art pure and simple than to that of the empirical sciences" (1947, p.9).

I have argued elsewhere that this style of mathematical creativity is in evidence in the TGEB. In particular, von Neumann explicitly adopts a "Modern" style, which involves alternating, in a largely opportunistic manner, between purely mathematical deduction

and heuristic justification. The guiding belief is that unearthing the formalism can reveal truths about the world. While the mathematics in the Theory of Games tends to be laborious rather than beautiful, von Neumann's exploration of stable set solutions to cooperative games provides many examples of this opportunistic mathematical philosophy in action. One is in Chapter 11, where, faced with the task of applying the stable set solution to non zero-sum games, he invents the device of the "fictitious player", in order to transform non-zero sum games into zero-sum. Another is in Chapter VII (pp. 314-320), where his exploration of the solutions to the zero-sum, 4-person game involves some subtle discussion, linking mathematical properties and features social organisation. I cannot convey the exact details here without entering upon several pages of technical presentation. Suffice it to say that heuristic consideration of the game leads to the suggestion of imputations (i.e., coalitions with their associated payoffs). These, however, are shown to be mathematically insufficient to constitute a solution (i.e., one that respects the technical criteria of the stable-set, which, as a formal entity has power for von Neumann). Thus, he adds the technically necessary imputations, and resorts to, on his own admission, somewhat contrived arguments in order to justify their inclusion. He admits freely that it is now the *mathematics* that is generating the plausibility arguments, and that he is not entirely convinced by the latter, but that this free flight of the mathematics is a well-known occurrence in mathematical-physical theories. In another variant further on, identifying a group of imputations that constitute a stable set, he even goes so far as to suggest that the complexity and delicacy of the particular social inter-relations described are "due to the solution rather than to the game itself" (p. 320). Parts of von Neumann's commentary in the Theory of Games are pervaded by an almost metaphysical faith in the formalism being constructed.

With this, Morgenstern was carried into mathematical terrain for which not even his most difficult lessons with Wald, or discussions with Menger, had adequately prepared him. It was one thing to look to Menger for exactitude in the law of diminishing returns, or for hints as to how to treat restricted maxims formally. It was quite another to be swept away in this mixture of empirics, deduction and aesthetics, where the mathematics became not merely a language for the representation of social relations but a repository of information about them. Morgenstern was the first of many to be astonished by the Theory of Games.

In his writings on game theory after 1944, Morgenstern, in general, stuck closely to several basic ideas: that game theory overcame the mistaken dependence on rational mechanics; that it provided a way of modelling strategic interaction (e.g., where the player does not control all the variables); that it provided a way of understanding the emergence of coalitions (here, he tended to emphasize the applications to monopolistic behaviour); and that it remained to be seen whether increasing the number of players in a game permitted the reassertion of perfect competition. In these writings, he orientates the theory of games towards possible economic applications, such as to imperfect competition. There is relatively little discussion of what had, for von Neumann, constituted a key impetus, namely the determination of social organization, with different equilibria depending upon social norms. Also, there is very little mention of the more

philosophically "adventurous" parts of the TGEB, such as von Neumann's difficult and sophisticated exploration of the mathematics of stable set solutions.

Conclusion

Morgenstern's engagement with foundational critique was a defining feature of his intellectual identity. He began as a near-typical product of the Austrian School, formed by Mayer and Mises, and concerned to show the impossibility of prediction, given the complexity of the interaction between the expectations, beliefs and decisions of heterogenous economic actors. His engagement with foundational critique continued, even when he himself began to pull away from his Austrian heritage.

There were at least two elements to his withdrawal from Austrianism. Firstly, the more he became involved with colleagues in mathematics, the more he learned to respect precise language, and, consequently, the more suspicious he became of the Austrian tendency, particularly amongst Mises and Hayek, to identify economics with a liberal politics. Secondly, his essays of the 1930's, on the need to properly account for time in economic theory, and on the need to specify the degree of foresight of agents in general equilibrium, are very much "Austrian"-inspired, but the manner in which Morgenstern looked to logic and mathematics for help was not. Because of the difficulties of responding to Austrian criticisms with formal, mathematical theories, Morgenstern inevitably found himself compromising his Austrianism, the closer he drew to the mathematical economists.

A key source of the tension pervading Morgenstern's writings, and private reflections, is the fact that while he made appeals to mathematicians for theoretical help, he himself was not mathematically trained, despite lessons and considerable efforts on his part. While in his intellectual dealings with Menger and Wald, he remained at arm's length from the mathematics, this changed when he was sucked into von Neumann's vortex. He now had to engage fully with a mathematician in the throes of creating a new work. Morgenstern's introduction to the Theory of Games and Economic Behavior emphasizes foundational matters. While this expresses the reasons why Morgenstern found the theory of games to be so attractive, it was a post hoc rationalization as far as von Neumann was concerned. His creation of game theory was sparked by personal engagements, not by foundational critique. Because the theory of games was not only mathematical but concerned with providing a static analysis of coalitions, it necessarily involved the disappearance of any remaining traces of Morgenstern's Austrianism, something that is reflected in his Princeton reassessment of his Viennese writings.

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