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Mises and the moderns on the inessentiality of money in equilibrium

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Abstract The challenge of rendering monetary exchange intelligible within a Walrasian general equilibrium framework is well known. Perhaps less well known is the difficulty of integrating monetary and exchange economies in decentralized conceptions of equilibrium, of which the evenly rotating economy of Ludwig von Mises (1949) is an early example. After reviewing the prospect for money in the evenly rotating economy, I survey the modern literature on frictions that make money useful for exchange. While exploring techniques commonly used to generate a useful role for money in this environment, I make a distinction between exchange frictions and epistemic frictions. Although theoretical efforts have largely focused on exchange frictions, recent experimental evidence suggests that epistemic frictions warrant further attention. I conclude that Mises should be seen as a pioneer in this literature, though recent advances demonstrate that the set of frictions capable of rendering money useful is much larger than he envisioned.

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Economists have long recognized the usefulness of money as a medium of exchange in overcoming the double coincidence of wants problem. However, rendering this observation intelligible within a general equilibrium framework has not come about so easily

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and, as a result, constitutes what is widely considered a fundamental problem in monetary economics.[1]

The difficulty of integrating monetary and exchange economies is easily observed when the equilibrium conception employed is of the Walrasian general equilibrium variety. Simply put, frictionless general equilibrium models leave little room for a useful medium of exchange.[2] With a central auctioneer setting all prices to clear a single common market and a central clearinghouse through which all goods are exchanged, money is incapable of improving the outcome.[3] In such a world, money is at best inessential; and if money is costly to use or store, equilibria where agents use money are Pareto inferior.

Interestingly, the problem remains when decentralized conceptions of equilibrium are employed. An early example is the evenly rotating economy of Ludwig von Mises (1949). In this context, wherein agents meet in decentralized exchange and prices are the result of their out-of-equilibrium bargaining, Mises (1949, p. 249) notes, "nobody needs to hold cash." That is, if market fundamentals were left unchanged such that the prevailing structure of equilibrium transactions persisted *ad infinitum*, agents would no longer find money useful.

After reviewing the prospect for money in Mises's evenly rotating economy, I survey the modern literature on frictions that make money useful for exchange. While exploring techniques commonly used to generate a useful role for money in this environment, I make a distinction between exchange frictions—which restrict what agents can do—and epistemic frictions—which restrict what agents can know. Although theoretical efforts have largely focused on exchange frictions, recent experimental evidence suggests that epistemic frictions warrant further attention. I conclude that Mises should be seen as a pioneer in this literature, though recent advances demonstrate that the set of frictions capable of rendering money useful is much larger than he seems to have envisioned.

1 Money in the evenly rotating economy

Ludwig von Mises employed a unique equilibrium construct known as the evenly rotating economy. In contrast to Walrasian formulations, exchange in the evenly rotating economy is decentralized. Although Mises is not entirely clear about the exchange environment, bilateral matching and turnpike-style trading seem plausible.[4] Technology and preferences are given and fixed in the evenly rotating economy; there is no change in data. As such, the future is certain and agents need not worry about resource supply shocks, technology shocks, preference shocks, or other disturbing forces. In this environment, and with all information, agents select equilibrium

[1] In what follows, I will limit my attention to money's usefulness as a medium of exchange in a general equilibrium framework. Other functions—unit of account, store of value, etc.—are not of direct concern.

[2] Marget (1935), pp. 154–163) considers the issues, while summarizing the efforts of Walras and his critics.

[3] Early efforts to include money in a general equilibrium model (e.g., money in the utility function, cash in advance constraint) amount to inclusion by assumption. More recently, Banerjee and Maskin (1996) generate money in a Walrasian general equilibrium model.

[4] Luther (2014) discusses the evenly rotating economy and argues it is similar in most respects to modern search theoretic models. See also: Cowen and Fink (1985).

strategies that indicate how much they will produce, save, and consume each period. The result is an equilibrium path of economic interactions through time.

Mises explicitly addresses the prospect of monetary exchange in the evenly rotating economy. "[T]he very notion of money," Mises (1949, p. 417) concludes, "vanishes into an unsubstantial calculation process, self-contradictory and devoid of any meaning." His logic is straightforward. If agents are operating in a continuous loop, repeating the same transactions again and again, each agent knows with whom along the equilibrium path they will trade goods for money and with whom they will trade money for goods. Carrying goods along the equilibrium path is desirable since agents along that path want to consume those goods. But no one consumes money; it is passed back and forth between agents with no obvious benefit. One could just as easily load and unload goods where equilibrium dictates without bothering to carry cash. Mises (1949, p. 249) claims bookkeeping would suffice.

Indeed, one could take the argument a step further. With unlimited cognitive capacity, as Mises implicitly assumes, agents can mentally note their transactions. As a result, physical bookkeeping is no longer necessary and the exchange equilibrium comes to rely exclusively on gift exchange. Except in the case of extraordinarily high discount rates, where individuals might be inclined to cheat, the threat of trigger strategies sustains the equilibrium. The evenly rotating economy is effectively reduced to a pure barter equilibrium by the prospect of gifting goods to one another along the equilibrium path.

Mises believed the inessentiality of money in equilibrium to be a tenuous result. The driving assumptions—namely, that fundamental values are known and constant—would almost certainly never be obtained. The hypothetical world of the evenly rotating economy merely allows one to elucidate, *a contrario*, the effects of change in a world of uncertainty. "In reality," Mises (1949, p. 247) writes, "there is never such a thing as an evenly rotating economic system." The underlying data are constantly in flux. Hence, money continues to serve a purpose in real world economies.

Although Mises correctly recognizes a valuable role for money if one lives in a world of change and uncertainty, he incorrectly claims the inversion of the proposition is true. "It is impossible to assign any function to indirect exchange, media of exchange, and money," Mises (1949, p. 417) argues, "within an imaginary construction the characteristic mark of which is unchangeability and rigidity of conditions." Even if Mises is right in noting that uncertainty and change provide a role for money, it does not follow that, absent uncertainty and change, their can be no role for money. In contrast, the modern literature suggests a meaningful role for money might remain if certain frictions are introduced.

2 Money in search-theoretic models with frictions

The modern approach to modeling monetary exchange builds on the work of Kiyotaki and Wright (1989, 1991, 1993). The Kiyotaki-Wright environment is typically populated with an infinite continuum of infinitely-lived agents. Agents are randomly matched, typically into pairs, such that exchange is decentralized.[5] These agents face

[5] Corbae et al. (2002, 2003) develop an endogenous matching model along the same lines. Hogan and Luther (2014) offer an endogenous matching model where some randomness remains.

the standard coincidence of wants problem *a la* Jevons.[6] As such, money might serve a meaningful role.

Working in the Kiyotaki-Wright environment, or extensions there of, modern scholars have sought to identify the necessary frictions for money to play a meaningful role. Money is described as essential if introducing money into the environment increases the set of allocations supported as equilibria.[7] In this section, a distinction is made between exchange and epistemic frictions. Exchange frictions occur when the modeler restricts the scope of action for agents operating in the model space. Epistemic frictions denote restrictions placed on what those agents can know. Although those working in the literature have not invoked the terminology of exchange and epistemic frictions, I believe these terms accurately reflect their intentions. Classifying models along these lines not only facilitates the assessment of a class of models—as opposed to the arduous task of assessing each model on its own—but also enables one to consider whether such a classification system—which has been implicit until now—is sensible. We address each class of models in turn before considering whether a fixed boundary exists between the two types of frictions.

2.1 Exchange frictions

In the Kiyotaki-Wright environment, exchange frictions are included by limiting contracts in at least two important respects. First, agents are not permitted to enter forward contracts. Every transaction is, in effect, a spot market transaction. The forward contracting restriction is typically embedded in the random matching component of the model, which gives no guarantee that two agents paired today will ever meet again. Indeed, the probability that any two agents are matched twice goes to zero as the population approaches infinity. Since it is prohibitively difficult to contract into the future with agents you will never meet again, the random matching component effectively (if not explicitly) prohibits forward contracts.

In addition to the forward contract restriction, agents are also precluded from entering contracts multilaterally. Restricting multilateral contracts gives teeth to the double coincidence of wants problem brought about by the bilateral exchange environment. If multilateral contracts were feasible, the mere fact that individuals *meet* bilaterally would be insufficient to generate a meaningful role for money. Agents could simply contract around the problem. Since agents meet in pairs, and have no way to communicate with the broader population, they cannot propose contracts whereby multiple agents agree to employ a specified strategy.

An example where multilateral forward contracts are permissible serves to illustrate the importance of these frictions in the Kiyotaki-Wright environment. Imagine that, just before agents begin the random matching protocol, a third party offers an enforceable contract whereby all agents can commit to exchange their production good anytime they are matched with another agent desiring it for consumption. Under some parameterizations of the model, such a contract would represent a Pareto improvement over

[6] Specifically, agents of type $\tau=\{1, 2, 3\}$ produce good $j=\tau+1$ modulo 3 but only consume good τ. The authors also consider a model where agents of type $\tau=\{1, 2, 3\}$ producing goods $j=\tau+2$ modulo 3 but consuming only τ are randomly matched.

[7] Some restrict use of the term "essential" to those cases where money *improves* the set of equilibria.

the monetary equilibrium. All agents would enter the contract and a non-monetary equilibrium would result. If such contracts were permissible (and enforceable), the bilateral random matching protocol would no longer generate a useful role for money. Hence, restrictions on multilateral forward contracts is one way of making money essential.[8]

As evidenced by the number of papers following Kiyotaki and Wright (1989), the search-theoretic environment with exchange frictions has proved quite useful. It is worth mentioning a few to illustrate the scope of topics covered in the literature. Matsuyama et al. (1993), Zhou (1997), and Trejos and Wright (1996) consider the emergence of an international monetary standard. Green and Zhou (1995) and Shi (1996, 1997) extend the model to allow for price level considerations. Aiyagari and Wallace (1997), Li and Wright (1998), and Hendrickson et al. (2015) allow for government transaction policies. Li (1995) looks at the optimal taxation of fiat money. Velde et al. (1999) address Gresham's law. Calvacanti and Wallace (1999) generate privately issued banknotes. Berensten (2006) assesses the viability of private outside monies. Burdett et al. (2001) explain cigarette money in POW camps. Curtis and Waller (2000) include illegal currency. And Cuadras-Morato (1997) asks whether perishable goods like ice cream can be used as money.

2.2 Epistemic frictions

Although exchange frictions are the standard approach used to generate a non-trivial role for money, some authors have considered the implications of relaxing the assumptions of hyperrationality or common knowledge.[9] In the theoretical literature, Williamson and Wright (1994) follow up on Alchian's (1977) suggestion that money is a means for overcoming problems arising from asymmetric information. In their formulation, each agent has the option of producing low- or high-quality goods but cannot directly observe the quality of a good another offers in exchange. The double coincidence of wants problem is replaced with an assessment problem. Money enters the environment as a standardized good, the quality of which can be observed by everyone. The authors are then able to articulate the cost-reducing role of money when asymmetric information regarding commodity quality is present.

Rather than introduce epistemic frictions into an equilibrium construction, many have concerned themselves with whether agents starting out of equilibrium—with less than complete information—can obtain the beliefs necessary to sustain the equilibrium pattern of behavior in a reasonable amount of time. Marimon et al. (1990), Staudinger (1998), Başçi (1999), Giansante (2006), Kawagoe (2007), and Hasker and Tahmilci (2008) take an agent-based computational approach to check the robustness of Kiyotaki-Wright models when the standard assumptions concerning information are relaxed.[10] In general, these authors find strong convergence to optimal behavior when the parameterization requires agents employ a medium of exchange with a lower

[8] Kiyotaki and Moore (2002) draw attention to limited commitment. Similarly, in the context of Townsend's (1980) turnpike model, Huggett and Krasa (1996) show that money is inessential unless commitment is limited.

[9] See: Selgin (2003).

[10] Yasutomi (1995, 2003) and Shinohara and Gunji (2001) use agent-based computational models to consider the emergence and collapse of money.

storage cost than their production good. However, agents are reluctant to trade their production good for a good that is more costly to store, even under parameterizations where doing so would enable them to trade for their consumption good so much more quickly as to warrant the additional cost.[11] In other words, agents are inclined to play *fundamental strategies*—offering to trade for goods with lower storage costs—even when they would do better to play *speculative strategies*—accepting higher storage costs in order to consume sooner. Başçi (1999) finds that allowing agents to learn by imitation (in addition to experience) increases the degree of equilibrium-consistent behavior under parameterizations where speculative strategies are justified.

Computer simulations certainly provide valuable insights as to the effects of including cognitive limitations in standard models. However, economics is ultimately concerned with *human* agents; and the criticism levied against standard theoretical approaches—namely, that they do not employ realistic algorithms of learning and understanding—can be extended to computational agent based models. Are the simple algorithms assumed in agent-based computational models really indicative of human behavior? If they are not, it is ambiguous as to whether the agent-based approach represents an improvement over the standard approach.

Concerned with the epistemic frictions faced by humans, some have placed human subjects in a laboratory version of the Kiyotaki-Wright environment (Brown 1996; Duffy and Ochs 1999, 2002; Duffy 2001).[12] Perhaps surprisingly, these controlled experiments yield results largely consistent with the agent-based approaches discussed above. Duffy and Ochs (1999) find that commodity monies emerge as predicted under parameterizations supporting fundamental strategies. Brown (1996) and Duffy and Ochs (1999) report that players are reluctant to employ speculative strategies. In the context of fiat monies, Duffy and Ochs (2002) make similar observations: players offer to trade for goods that lower their storage costs, even under parameterizations where they would do better to accept higher storage costs in order to consume sooner. Duffy (2001) uses automation techniques to increase the level of speculation observed.

2.3 On the fixed boundary between exchange and epistemic frictions

Although it is maintained herein that a meaningful distinction can be made between exchange and epistemic frictions, that distinction is not quite as clear as one might hope—that is, there is no fixed boundary.

Consider the contractual restrictions discussed in Section 3.1 above. The desirability of contracts, one might argue, necessarily implies epistemic limitations. Why write a contract if agents are all knowing and hyperrational? If the contract between such agents is self-enforcing, it need not be written. If the contract is not self-enforcing, a third party must provide enforcement if it is to comprise a binding constraint. However, the presence of a third party contract enforcer does not remedy the problem. After all, the contract enforcer is merely a party to a secondary contract with the original two parties whereby it is agreed that, in the event of a dispute, the third party will enforce the primary contract. Like the primary contract, the secondary contract is either self-

[11] Similarly, Kawagoe (2007) shows that, contrary to theory, agents are reluctant to employ a perishable good as money.

[12] Duffy (2010) surveys the relevant literature.

enforcing or requires still another party to enforce it. The latter case would require a tertiary contract. In order to avoid an infinite regress, the layers of contractual relationships must be self-enforcing at the last stage. And if it is self-enforcing at the last stage, all the layers can be bundled into a single contract that is self-enforcing. Since the only enforceable contracts between all knowing and hyperrational agents are self-enforcing contracts, and since self-enforcing contracts need not be written, agents devoid of epistemic shortcomings need not bother with contracts.

Contracts are a useful aid in the presence of epistemic limitations. Prior to an agreement, a contract specifies what is to be agreed upon. Writing out the terms in advance gives all parties involved the ability to reflect on the details of a transaction and, if necessary, request still further clarification concerning the proposal. Should a dispute occur, the contract provides a record of the agreement. In both cases, contracts are useful insofar as they remove ambiguity. If agents are all knowing and hyperrational, there is no potential for miscommunication or forgetfulness and, hence, no role for contracts. That exchange frictions are needed to prevent contracting in the models discussed in Section 2.1 suggests epistemic frictions of some sort are embedded in those models. In what follows, I review various efforts to get at the underlying epistemic frictions in the Kiyotaki-Wright environment.

One epistemic friction embedded in the Kiyotaki-Wright environment is the private nature of past actions, often referred to as the anonymity of exchange. Simply put, agents are unable to observe or recall the past actions of players with whom they are presently matched. Since past actions are private information, agents find it difficult to use reputations or other quasi-contractual mechanisms to ensure that goods are transferred along the equilibrium path. Money emerges in part to overcome the private information problem, facilitating exchange in an anonymous world. Along these lines, Kocherlakota (1998) shows that any incentive-feasible allocation in an environment with non-divisible money can be achieved with memory. Kocherlakota (2002) extends the analysis to show that, if money is divisible and money holdings are observable, money weakly dominates other forms of memory; and if money holdings are not observable, two monies are sufficient to provide complete memory. These studies serve to emphasize the usefulness of money as a recordkeeping device.[13] Without epistemic limitations, agents could transact by maintaining imaginary balance sheets. Providing consumption goods to another would cause one's balance to rise, where a positive balance reflects transfers to be received in the future. Receiving a consumption good from another, on the other hand, would cause one's balance to fall. "In the monetary environment," Kocherlakota (1998, p. 233) explains, "money is merely a physical way of maintaining this balance sheet." Hence, the benefit of money is most pronounced when epistemic limitations make mental bookkeeping impossible.

For a significantly small population, Araujo (2004) shows that neither money nor memory is necessary to sustain the best-case equilibrium scenario. Even though past actions are (strictly speaking) private information, an agent in a small population is capable of communicating defection to the rest of the population quickly enough to bring all single-coincidence trading to a halt. To see clearly, one might consider the

[13] On money as a recordkeeping device, see also Kocherlakota and Wallace (1998) and Wallace (2001). Along similar lines, Kahn et al. (2005) consider the privacy-providing role of money—that is, its ability to alleviate the need for recordkeeping. Luther and Olson (2015) maintain that bitcoin is a form of memory.

simple three good, three type Kiyotaki-Wright model amended such that population N=9. In this environment, all agents could agree to play a trigger strategy such that one always offers to trade in double-coincidence meetings, regardless of past experience, but only offers to trade in single-coincidence meetings (where the agent with whom you are matched desires to consume the good you currently hold in storage) if everyone with whom the agent has been previously matched has done likewise. In contrast to the standard model populated by an infinite continuum of agents, a single defection from the established social norm would quickly ripple throughout the small population since the probability of being matched with the person observing defection in the period immediately following the defection when N=9 is 1/8.[14] Although most agents would not know who initially defected, they would soon find themselves matched with another employing the trigger strategy and follow suit. In just a few rounds, all single-coincidence trading would cease and the original defector would be punished (along with everyone else!). Assuming agents are reasonably patient, the prospect of eliminating single coincidence trading is sufficient to discourage defection in a small population. When populations are large and highly specialized, however, it is difficult to punish the initial defector. To sustain the most desirable outcome for such parameterizations, money (or memory) is essential.

In the context of a more recent model, the question of the inessentiality of money has taken center stage.[15] Lagos and Wright (2005) extend the standard search-theoretic random matching model of money to provide an analytically tractable macroeconomic model. Their approach differs in that, following each period of random bilateral matching, agents participate in a centralized Walrasian market. The decentralized, anonymous nature of odd period play makes money essential. The centralized, general nature of even period play allows for straightforward considerations of macroeconomic variables (e.g., the price level, welfare cost of inflation). Hence, Lagos and Wright (2005) provide microfoundations for money in a general equilibrium context without sacrificing much in the way of tractability.

The problem with the Lagos-Wright model, according to Aliprantis et al. (2007a, b), is that the centralized market provides a forum whereby those defecting from the social optimum can be punished, thereby rendering money inessential.[16] Recast as an infinitely repeated game with observable individual actions (i.e., many but not infinite agents), the authors show that anonymity and random pairings are insufficient to make money essential. As in Araujo (2004), agents are presumed to establish a social norm and sanctions for undesirable behavior. Whereas the small population in that environment allowed defection to be communicated to all agents after a few rounds of play, Aliprantis et al. (2007a, b) maintain that, in the modified Lagos-Wright environment, everyone learns of the deviation with at most a one period delay. If agents are sufficiently patient, and actions are perfectly observable (i.e., there is no

[14] In general, the probability of being matched with a given agent is $1/(N\text{-}1)$. As $N \to \infty$, the probability of being matched with the person observing the defection (and, hence, the potency of the trigger strategy) goes to 0.

[15] See Williamson and Wright (2010, p. 33).

[16] Lagos and Wright (2007) reject the notion that centralized markets necessarily imply agents can observe the actions of others; they maintain that agents only observe prices in the standard Walrasian model, which they attempt to mimic in the centralized component of Lagos and Wright (2005). See also: Aliprantis et al. (2006), Araujo et al. (2010).

noise to create a wedge between one's decision to offer a good in exchange and the offering of a good in exchange), the socially desirable outcome is achievable in the absence of money. Hence, money is inessential.

The debate between Lagos and Wright (2005, 2007) and Aliprantis et al. (2007a, b) is useful to recall as it forms the basis of a new experimental study on the essentiality of money. Duffy and Puzzello (2014) design an experiment with human subjects wherein money is inessential. As in the Lagos-Wright model, players alternate between decentralized and centralized trading rounds. In one treatment, a subset of players are endowed with money. The first-best response under the parameterization implemented is to dispose of all fiat money holdings in the first period and gift a production good upon being matched with another desiring it for consumption, regardless of whether the meeting involves a single or double coincidence of wants. Alternatively, players might coordinate on a less efficient monetary equilibrium or a still worse non-monetary, autarkic (no trade) equilibrium. The second treatment differs in that no players are endowed with (nor produce) money. In this treatment, players might coordinate on the first-best gift-exchange equilibrium or the autarkic equilibrium.

In contrast to the prediction of Aliprantis et al. (2007a, b), Duffy and Puzzello (2014) find that human subjects acting in a controlled environment are unable to coordinate on the first-best non-monetary equilibrium. When available, participants in their study typically choose to employ money in order to avoid the autarkic equilibrium.[17] In the no-money treatment, subjects are even closer to the autarkic no-trade equilibrium. Welfare is significantly higher in treatments with money than in treatments without money. Hence, the ability to use money helps players avoid much worse outcomes. The authors conclude that, while not *theoretically* essential in the environment considered, money is *behaviorally* essential.

The experimental study of Duffy and Puzzello (2014) serves to illustrate the epistemic limitations of human subjects in addition to those typically included in models of money (i.e., private information of past actions). Of course, one can only speculate at this point as to why the institution of money seems to be more robust than other commitment-based institutions. Perhaps a limited cognitive capacity precludes human subjects from employing more complicated social norm strategies, whereas money provides an easy way to keep track of transactions. Alternatively, human subjects might not trust one another or might not be confident that others view them as trustworthy. In this case, money serves as a physical verification that goods have been rendered to others in the past. Future work in this area would do well to isolate the particular epistemic flaws of human subjects creating the void for money to fill.

3 Mises in light of the moderns

Having summarized the modern literature on the inessentiality of money, it is worth reconsidering the work of Mises to assess—at least from a modern perspective—what he got right and where his analysis fell short. Based on my assessment, Mises should be seen as a pioneer in this literature. Indeed, the supposed shortcomings in his work

[17] The authors report the range of trades in decentralized periods involving money over the 12 sessions as 80–100%.

probably stem from the unique methodological approach of the Austrian school, with its emphasis on disequilibrium processes. Those eschewing such an approach can rightly point out that some conclusions reached by Mises do not strictly follow. However, those working in the Austrian tradition might just as easily conclude that the exposed errors are inconsequential. After all, the cases overlooked by Mises are all confined to an equilibrium state that, according to the Austrian view, is never really obtained.

Consistent with the modern view, Mises demonstrated that the common result concerning the inessentiality of money in equilibrium was not due to the equilibrium construct employed. Although many had attributed this result to the centralized nature of the Walrasian framework, Mises showed that money could also be rendered inessential in the decentralized equilibrium of the evenly rotating economy. He attributed the result not to the equilibrium construct employed, but rather to the "unchangeability and rigidity of conditions" commonly assumed in such models (Mises 1949, p. 417). His conclusion resonates with the moderns, who stress that—centralized or decentralized—such environments lacked the necessary frictions to provide a useful role for money.

Mises also foreshadowed the modern idea that money is memory. In a frictionless equilibrium, "All transactions can in fact be effected through transfer in the bank's books without any recourse to cash. Thus the 'money' of this system is not a medium of exchange; it is not money at all; it is merely a numeraire, an etheral and undetermined unit of accounting of that vague and indefinable character which the fancy of some economists and the errors of many laymen mistakenly have attributed to money" (Mises 1949, p. 249). This idea—that money as a medium of exchange could be replaced with a record-keeping device or accounting practice in frictionless equilibria—would later be expressed by Ostroy (1973), Lucas (1980), and Aiyagari and Wallace (1991), among others; it has receive its clearest statement in Kocherlakota and Wallace (1998) and Kocherlakota (1998, 2002).

While Mises comes close to articulating many modern views on the inessentiality of money in equilibrium, his conclusion that change and uncertainty are necessary conditions for money to play a useful role does not follow. It is certainly true that change and uncertainty are lacking in his equilibrium construct, where money is inessential. However, these are not the only frictions that are missing in his model. As described above, modern economists have done much work on other exchange and epistemic frictions that might provide a useful role for money in equilibrium.

Perhaps it is not surprising—or even material—that Mises commits the inverse fallacy. He is ultimately concerned with a disequilibrium world. To Mises, the evenly rotating economy is a logical foil. It is a limiting notion that enables one to understand the movement, or market process, involved in getting to that state. As Mises (1949, p. 353) explains, "Logical economics is essentially a theory of processes and changes. It resorts to the imaginary construction of changelessness merely for the elucidation of the phenomena of change." He (and those working in the Austrian tradition) is primarily concerned with the process. Indeed, many Austrians reject that the end-state is ever fully obtained.[18] Since Mises is explicitly looking for the conditions that lead to the

[18] According to Rothbard (1962, p. 322), "the final equilibrium position is always changing, and consequently no one such position is ever reached in practice. […] it is like the mechanical rabbit being chased by the dog. It is never reached in practice and it is always changing, but it explains the direction in which the dog is moving."

essentiality of money *outside* the general equilibrium environment of the evenly rotating economy, it is probably unfair to fault him for failing to properly specify the conditions for money to serve a useful role *inside* a general equilibrium environment.

Whereas Mises focused primarily on the usefulness of money in a disequilibrium world, the modern literature aims to find the precise frictions (or sets of frictions) that render money useful in equilibrium. Much progress has been made in this direction. Whether the modern aim is appropriate and, perhaps more to the point, whether those working in the Austrian tradition should adopt such an aim is well beyond the topic at hand. Still, it is worth noting what is at issue in answering these questions. To be clear: it does not depend on whether one thinks the world is marked by change. Virtually everyone agrees that the world is dynamic and modern conceptions of equilibria reflect this view. Rather, it depends on whether one thinks the world is probabilistic or ambiguous. If everything that can ever be might be fully specified by a probability distribution, the modern approach is clearly the way to go. If, instead, some parts of the future are unknown and unknowable—that is, if they are marked by genuine uncertainty—some scope for traditional Austrian analysis remains.

Regardless of one's view on the usefulness of Austrian economics in the future, there is much to be admired in the work of Mises on the usefulness of money. He was certainly ahead of his time. Mises developed a dynamic decentralized equilibrium model to consider monetary exchange. He showed that money is inessential in a frictionless version of this model. And, finally, he offered an early statement of the money is memory view. Although his work falls short of providing the final statement in monetary economics, his progress should be acknowledged.

4 Conclusion

To some, it will no doubt be surprising that Mises, writing in the middle of the twentieth century, foreshadowed the now-prevalent search-theoretic bilateral exchange models of money. Perhaps even more surprising is how closely his conjectures line up with the more mathematically rigorous models developed over the last few decades. Mises recognized money was inessential in frictionless general equilibrium models, regardless of whether they were centralized or decentralized. Although he did not attempt to isolate the various exchange and epistemic frictions which might create a role for money in equilibrium and, indeed, generally held that uncertainty and continual change was the *only* source of money's usefulness, his understanding that common knowledge and the ability to commit rendered money inessential was well ahead of his time.

In general, modern theoretical work confirms that all-knowing hyperrational agents have little use for money. In economies populated by human subjects, however, epistemic frictions like the private nature of past actions create a roll for money. Various institutions emerge to bridge the gap between hyperrational and human agents. In cases where non-monetary institutions are costly, ineffective, or prohibited—that is, when exchange frictions are present—money can serve a useful role in facilitating exchange. In still other cases when non-monetary alternatives require more cognitive capacity or social capital than human subjects can muster, money fills the void. In either case, money is fundamentally a tool to overcome our epistemic shortcomings; it is a human institution that has evolved to overcome human imperfections.

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