

## Unit of account or medium of exchange? Reply \*

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In his thoughtful comment on our paper (Aschheim and Tavlas 2006), Leland Yeager takes issue with our thesis that the primary function of money is that of numéraire. While Yeager (2007, p. 196) “would agree [...] that a single unit of account in a currency area is more important than a single medium of exchange”, he also argues that “both the unit-of-account [...] and medium-of-exchange functions of ‘money’ characterize an efficient reckoning [of the] payments systems” (*ibid.*, p. 195). Thus, “[b]oth functions are important in economic life and in monetary theory [...] and it is difficult] to measure and compare *degrees* of importance” (*ibid.*, p. 204, original italics).

We are grateful to Professor Yeager for his commentary. We would like to point out, however, that, in our paper, we addressed criticism to those contemporary economists – evidently an overwhelming majority – who assign primacy to the medium-of-exchange function of money.<sup>1</sup> Professor Yeager has a different view from that of most other economists. He believes that the two functions deserve equal billing. In what follows, we briefly elaborate on our view that the numéraire deserves top billing, both analytically and in practice.

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<sup>1</sup> For example, Krugman and Obstfeld (2003, p. 358) wrote: “The most important function of money is to serve as a *medium of exchange*” (original italics). They went on to state: “Money’s second important role is as a *unit of account*” (original italics). Similarly, Gordon (2000, p. 106) argued: “The most important function that differentiates money from other assets is its role as *medium of exchange*” (original italics).

## 1. Analytic considerations

As noted above, Yeager argues that both functions of money are equally important in economic theory. In our paper, in contrast, we argue that the numéraire function is more important than that of medium of exchange in theoretical analysis.

To illustrate the importance of the numéraire in theoretical investigation, consider the case of Pareto optimization in a one-period, representative-agent model comprised of a single, utility-maximizing, household and a single firm.<sup>2</sup> In this simple model economy, there are two goods – a consumption good and leisure (or time not working in the market). One unit of labor time exchanges for  $w$  units of consumption goods, with the consumption good playing the role of the numéraire. The consumer's goal is to choose consumption and leisure to make himself or herself as well off as possible subject to his or her budget constraint. The firm demands labor and supplies consumption goods, with its choices determined by the available production technology and profit maximization. Under certain conditions (i.e., a constant-returns-to-scale production function, a price-taking consumer), it can be shown that the firm optimizes when the value of the marginal product of labor equals the real wage while the consumer optimizes at the point at which the marginal rate of substitution of leisure for consumption equals the real wage. That is, a competitive equilibrium obtains when both the value of the marginal product of labor and the marginal rate of substitution of leisure for consumption equal the real wage, the numéraire of the system. A Pareto optimum is the point on the consumer's utility function and the firm's production possibility frontier at which the consumer is as well off as possible, given the technology for producing consumption goods using labor as an input, and the firm maximizes profits (at the point where marginal revenue equals marginal cost, or  $w$ ) (Williamson 2005, pp. 142-43). In this simple framework, it is straightforward to show that, under certain conditions, a competitive equilibrium is Pareto optimal (i.e., the first fundamental theorem of welfare economics holds) and that

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<sup>2</sup> For a thorough treatment, see Williamson (2005, chapter 5).

a Pareto optimum is a competitive equilibrium (i.e., the second fundamental theorem of welfare economics holds).<sup>3</sup>

Crucially, the equivalence of a competitive equilibrium with Pareto optimality can be ascertained *without* a medium of exchange. In this model economy, there is no need to invoke a cash-in-advance constraint or to put money in the consumers' utility function, the usual techniques for introducing a transactions medium into a model. However, the existence of the numéraire is a necessary condition for determination of the Pareto optimum. Without the numéraire, the system is not solvable. In more complicated systems (e.g., extension to multi-period analysis), showing whether the first and second welfare theorems hold can be difficult. Nevertheless, the existence of a numéraire is necessary to solve the systems. The numéraire constitutes what we have called *embryonic money* (Aschheim and Tavlas 1996).

## 2. Practical aspects

How might the primacy we accorded to role of the numéraire be shown in practical application? To provide a specific example, consider the creation of the European Payments Union (EPU) in 1950. The EPU came into operation to deal with the US dollar shortage in the aftermath of the Second World War. Its members were essentially the countries of Western Europe and their overseas dependencies.<sup>4</sup> With the United States holding the bulk of gold reserves, and with the dollar the only international currency serving as a generally-acceptable reserve asset and medium of exchange, intra-European trade was smothered by widespread restrictions on current-account transactions. Essentially, European countries did not have sufficient quantities of the medium of exchange (i.e., the US dollar) to engage in international trade. To deal with the dollar-shortage problem, the EPU effectively eliminated, or greatly reduced, the need of a medium of

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<sup>3</sup> Among the conditions required for a competitive equilibrium are the following: 1) consumer optimization, 2) profit maximization by firms and 3) equality between the quantities of labor demanded and supplied. With a government sector introduced in the one-period model, competitive equilibrium requires that government spending equals government revenue.

<sup>4</sup> See Yeager (1976, pp. 411-22) and Eichengreen (2007, pp. 79-85) for detailed discussions of the EPU.

exchange. Each member country's debits and credits to all other members of the EPU were totaled every month. A particular country would be liable to pay only its net debit balance at the end of each month or, conversely, it would receive only its net credit balance each month. All other transactions would cancel against each other. In this way, the need of the dollar as a medium of exchange was greatly diminished.

Now suppose, hypothetically, that in a particular month all members of the EPU had zero net aggregate balances, allowing the possibility of non-zero bilateral balances. In such a situation, there would be no intra-EPU monetary transactions at the end of the month. That is, no money would be exchanged. Money would not function as a medium of exchange. Yet, the unit-of-account function would have been necessary to tabulate each member's transactions with all other members. Though goods would have exchanged for goods, the existence of the unit of account was the necessary and sufficient condition for exchange. Some writers might describe this example as barter exchange since money did not change hands. Underlying the exchange, however, was the unit of account. This is the reason we prefer to call this example a monetary-exchange transaction (Aschheim and Tavlas 1996).

In fact, a medium of exchange can be used to conduct transactions without the medium's changing hands. In his regard, Tobin (1992) pointed out that, on the island of Yap, debts were settled by changing ownership of large immovable stone wheels. As Tobin (*ibid.*, p. 771) also observed, "the practice continued after the sea flooded their site and the stones were invisible at the bottom of a lagoon". An issue that Tobin did not address concerns why such unlikely objects as immovable stones were selected to be media of exchange in the first place. This issue was dealt with by Del Mar (1895), who noted that the inclination of some societies to use large objects as money arose as a result of the need of a numéraire: thus, Del Mar (*ibid.*, p. xxxiv) pointed out that the ancient "states of Iona, Byzantium, Sparta and Athens" created

"discs of purposely rotted sheet iron or bronze, having no value as pieces of metal, but possessing great and definite value of public measure".<sup>5</sup>

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<sup>5</sup> For a discussions of Del Mar's views, see Aschheim and Tavlas (2004 and 2006).

Because the pieces of metal served as numéraire, they

“enabled any exchange to be effected upon a more equitable basis than before simply by [...] holding a vast number of parities in view at once” (*ibid.*, p. xxxi).

Del Mar’s systematic analysis of the role of the numéraire is one reason that, in our paper, we singled him out as a progenitor of the chartalist theory of money (Aschheim and Tavlas 2006).

Finally, consider the example of the use of cigarettes as money in prisoner-of-war camps. Citing the original contribution by Radford (1945) on this subject,<sup>6</sup> Yeager suggests that cigarettes emerged spontaneously and simultaneously as *both* a medium of exchange and a unit of account (see, also, Tobin 1992 and Meltzer 1995). We have a somewhat different view. Consider the following.

First, several factors contributed to the use of cigarettes as the medium of exchange in prisoner-of-war camps. Cigarettes are portable, divisible (in that a packet of cigarettes is divisible into its components), and (to some extent) storable, fundamental requirements of a medium of exchange. Cigarettes also possess intrinsic value, a helpful attribute for a medium of exchange in the absence of government fiat. Clearly, it was in the interests of the members of prisoner-of-war camps to settle on a medium of exchange to narrow transaction chains *and* on a unit of account to simplify calculations. But which function came first? Radford’s (1945, p. 191) first-hand account is informative:

“By the end of a month, when we reached our permanent camp, there was a lively trade in all commodities and their relative values were well known, and expressed not in terms of one another – one didn’t quote bully in terms of sugar – but in terms of cigarettes. The cigarette became the standard of value. In the permanent camp people started by wandering through the bungalows calling their offers – “cheese for seven” (cigarettes) – and the hours after parcel issue were Bedlam. The inconveniences of this system soon led to its replacement by an Exchange and Mart notice board in every bungalow, where under the headings “name”, “room number”, “wanted” and “offered” sales and wants were advertised. When a deal went through, it was crossed off the board. The public and semi-permanent records of transactions led to cigarette prices being well known and thus tending to equality

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<sup>6</sup> Radford had been a prisoner of war in Italy during the Second World War.

throughout the camp, although there were always opportunities for an astute trader to make a profit from arbitrage. With this development everyone, including non-smokers, was willing to sell cigarettes, using them to buy at another time and place. Cigarettes became the normal currency, though, of course, barter was never extinguished”.

Thus, in prisoner-of-war camps the members of the group apparently first settled on a numéraire and then on a medium of exchange.

Second, a case can also be made that the soldiers in prisoner-of-war camps had *pre-existing* conceptions of numéraires with which to make calculations – namely, their national currencies. For example, US soldiers who were prisoners of war were geared to transact (and think) in terms of US dollars, having spent their lifetimes prior to imprisonment doing so. With the US dollar serving as pre-existing numéraire, it was straightforward to calculate relative values of tradable objects, including cigarettes, in terms of their values in dollars. As we discussed above, in such circumstances there were logical reasons to settle on cigarettes as transactions media. To the extent that trade in prisoner-of-war camps may have been carried out in the context of a pre-existing concept of the numéraire, this example illustrates the feasibility of the notion, cogently argued by Greenfield and Yeager (1983), that it is possible to separate the unit of account from the medium of exchange in real-world situations.

### 3. Concluding remarks

Professor Yeager has provided an insightful presentation of the view that the numéraire and the medium of exchange functions of money are equally important. In this regard, he stands apart from the majority of contemporary economists who 1) assign top billing to the medium-of-exchange function, 2) do so without systematic analysis to support their view and 3) characterize general-equilibrium models without a medium of exchange, but *with* a numéraire, as barter models (e.g., Gordon 2000, p. 106; Champ and Freeman 2001, pp. 33-45). One of the principles that emerged from the rational-expectations revolution in economics is that macro models and concepts should be grounded in solid microeconomic foundations, including the prefer-

ences, endowments and technologies of optimizing consumers and firms. It appears, however, that, in contrast to Yeager, for the majority of economists this principle has not been extended to the analysis of the functions of money.

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