The paper by Bencivenga and Camera (2011, this issue) studies how banks can improve the allocation of resources in an environment where trading frictions make money useful for certain types of exchange. Its starting point is the observation that the random nature of trading opportunities commonly used in modern monetary models is structurally similar to a type of liquidity-preference uncertainty that appears in the banking literature. It seems natural, therefore, to ask what insights can be gained by combining these separate strands of research. The paper presents a model of decentralized trade in which banks arise endogenously as an arrangement for efficiently distributing cash to agents when they have attractive buying opportunities. It then studies the relationship between inflation and the functioning of the banking system, as well as the effects of a central bank policy of paying interest on bank reserves. The paper is part of an important research agenda that aims to study financial institutions in general equilibrium models where money plays an explicit role.

The model in the paper builds on that in Lagos and Wright (2005), where agents alternate between trading in centralized and decentralized markets and the information structure is such that decentralized trade requires the use of money. Agents can hold their wealth in either money or capital; capital typically offers a higher rate of return but cannot be used to purchase goods in decentralized trade. When making portfolio adjustments in the centralized market, an agent is unsure what trading opportunities will be available to her in the subsequent decentralized market and, hence, how much money she will want to hold. The banking literature that began with Bryant (1980) and Diamond and Dybvig (1983) showed how an institution that resembles a bank can be welfare enhancing when agents face a similar type of uncertainty. The models in this literature were written entirely in real terms, however, which limits their ability to address monetary issues such as the effects of inflation. Bencivenga...
and Camera introduce this type of banking arrangement into a monetary model through a technology that allows agents to withdraw cash from their bank when they encounter a consumption opportunity in the decentralized market. The presence of this technology allows a bank’s depositors to collectively hold less of their wealth in money and more of it in productive capital.

In this discussion, I compare the economic role that banks play in the Bencivenga–Camera model to the roles studied in the earlier banking literature. Banks in the Bencivenga–Camera model serve a clear and very intuitive purpose: they allocate cash to agents based on their liquidity needs. Interestingly, however, this role is different from the one played by banks in the classic paper of Diamond and Dybvig (1983) and much of the subsequent banking literature. In the original Diamond–Dybvig model, there is a single asset in the economy and, hence, no need to divide portfolios between “money” and other assets. A bank in that model provides its depositors with insurance against the uncertainty about their future liquidity preferences.1 This insurance role does not arise in the Bencivenga–Camera model. In what follows, I use a very simple model to illustrate both of these roles and relate them to the Bencivenga–Camera analysis.

1. AN ILLUSTRATIVE MODEL

Bencivenga and Camera construct a rich model of monetary exchange. My aim here is to illustrate the role that banks can play in this type of environment in the simplest possible way. To do so, I present a simplified version of the model in Jacklin and Bhattacharya (1988) that, while very stylized, captures some of the essential features of the richer model in the paper.

1.1 The Environment

There are three time periods, \( t = 0, 1, 2 \), and a large number of agents. Each agent is endowed with one unit of the single consumption good in period 0 and has preferences over consumption in periods 1 and 2 given by

\[ \theta_i u(c_1) + v(c_2), \]

where \( \theta_i \in \{\theta_H, \theta_L\} \), with \( \theta_H > \theta_L \), and the functions \( u \) and \( v \) are strictly concave. The endowment can be divided between two constant-returns-to-scale investment technologies, labeled “money” and “capital.” Investment in capital must be held until period 2 and yields a return \( R > 1 \). Investment in money yields a return of 1 if held

1. The liquidity-allocation role has appeared in some of the literature following Diamond and Dybvig (1983). Cooper and Ross (1998), for example, introduce portfolio choice and liquidity allocation into an otherwise standard Diamond–Dybvig model. In addition, a large number of papers follow Champ et al. (1996) in studying the liquidity-allocation role of banks in monetary models with overlapping generations of agents.
for one period but yields a lower return $1/\pi$ (with $\pi > 1$) if held for two periods. Investment decisions must be made at $t = 0$, but an agent’s type $\theta_i$ is not revealed until $t = 1$. Types are private information. For simplicity, assume that the probability of being each type is $1/2$ for every agent.

Period 1 in this simple model corresponds to the decentralized market in the Bencivenga–Camera model, while $t = 2$ corresponds to the centralized market. The uncertainty about the desirability of the “decentralized” good, captured by the preference parameter $\theta_i$, directly matches the Bencivenga–Camera setup. The assumptions on investment technologies here imply that consumption at $t = 1$ can only be obtained by holding the investment labeled “money,” which captures—in a very brute-force way—the idea that money is necessary for decentralized trade. The variable $\pi$ represents the inflation rate, which determines the real return to holding money between periods 1 and 2.

1.2 Autarky

If an agent invests her endowment directly, her budget constraint is

$$c_2 \leq Rk + \frac{1}{\pi} (m - c_1) ,$$

together with the restriction $c_1 \leq m$ and the feasibility constraint $m + k \leq 1$. As the expression above illustrates, consumption at $t = 2$ is equal to the return on investment in capital plus the return on any money that was not used at $t = 1$. The frontier of the budget set is depicted in Figure 1 for three different portfolio choices. The lower-most line would be the constraint if the agent held only money, that is, if she
set \( k = 0 \). When \( k \) is positive, the budget line shifts up because capital offers a higher return than money. However, the line is also truncated by the restriction \( c_1 \leq m \). The upper-most line in the figure corresponds to a higher choice of \( k \), which allows for larger values of \( c_2 \) but places an even tighter restriction on \( c_1 \). In all of these cases, the slope of the budget line is \( 1/\pi \), which is the return on any money held until \( t = 2 \).

In period 1, after \( \theta_i \) is realized, the agent will choose the point on the budget line that maximizes her utility. The optimal choice will typically depend on the realized value of \( \theta_i \). In the situation depicted in the figure, the agent will choose to convert all of her money holdings into consumption at \( t = 1 \) if she is of type \( \theta_H \), but she will use only part of her money at \( t = 1 \) if she is type \( \theta_L \). In this case, the remainder of her money will be held until \( t = 2 \) and will yield the low return \( 1/\pi \).

1.3 Banking I: Allocating Liquidity

The allocation of money holdings in the autarky allocation described earlier is clearly inefficient. As shown in Figure 1, once preference types are realized, type \( L \) agents are holding more money than they want to spend, while type \( H \) agents are liquidity constrained. The decentralized nature of the market prevents type \( L \) agents from loaning some of their money holdings to type \( H \) agents.

Bencivenga and Camera introduce a technology that allows agents to pool their resources in a bank at \( t = 0 \) and to withdraw money from this bank at \( t = 1 \) after observing their trading opportunities. The bank is assumed to offer a standard demand-deposit contract that allows an agent to choose how much of her deposit to withdraw in each period and pays interest on deposits at a rate that depends on when the funds are withdrawn. To see how this arrangement raises welfare in our simple model, suppose that funds withdrawn at \( t = 1 \) earn a (gross) rate of return of 1, while funds withdrawn at \( t = 2 \) earn the return \( R > 1 \). Importantly, agents are able to make their withdrawal plans after they observe their realized preference types at \( t = 1 \). For an agent who deposits in this bank, the set of combinations \((c_1, c_2) \in \mathbb{R}_+^2\) that are feasible under this banking contract is given by

\[
c_1 + \frac{c_2}{R} \leq 1. \tag{2}
\]

Figure 2 depicts this budget set along with the optimal choice of each type of agent. Letting \((c_{1,H}, c_{2,H})\) denote the consumption bundle chosen by an agent of type \( H \), the bank would then divide its portfolio so that

\[
m^* = \frac{1}{2} \left( c_{1,H} + c_{1,L} \right) \quad \text{and} \quad k^* = \frac{1}{2} \frac{c_{2,H} + c_{2,L}}{R}. \tag{3}
\]

The fact that each agent’s choice satisfies the budget constraint (2) implies \( m^* + k^* = 1 \), which shows that this banking arrangement is feasible.

The benefit of this arrangement is clear from a comparison of Figures 1 and 2. The bank ensures an \textit{ex post} efficient distribution of money by allowing type \( H \) agents to withdraw more at \( t = 1 \) and type \( L \) agents to withdraw less. Because there is no
uncertainty about aggregate liquidity demand, the bank is able to perfectly forecast withdrawal demand at $t = 1$ and can avoid holding money balances between $t = 1$ and $t = 2$. As a result, both types of agents reach higher indifference curves. This is the role banks play in the Bencivenga–Camera model: allocating cash balances efficiently across agents once preference types have been realized.

Bencivenga and Camera assume that contacting a bank in the decentralized market is costly. This interesting and realistic friction implies that an agent will only choose to use the banking technology when the benefit of doing so is sufficiently large. Comparing Figures 1 and 2, it is fairly easy to see that the benefit offered by the banking technology is largest when the return on money is low, that is, when the inflation rate $\pi$ is high. As inflation becomes lower, the budget lines in Figure 1 become steeper because holding idle money balances is less costly. In the extreme case where return on money is equal to $R$, which corresponds to the Friedman rule, the budget constraint under autarky with $k = 0$ is equivalent to the budget constraint generated by a bank. In this case, the bank does no better than the agents could do in autarky. The paper shows that, holding the cost of contacting the bank fixed, the banking system will be active if and only if the equilibrium inflation rate is high enough.

The allocation of resources achieved through the banking technology can also be depicted using an Edgeworth box diagram for a representative agent of each type, as shown in Figure 3. The origin for the type $H$ agent is the southwest corner of this

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2. It also implies that agents may choose to hold some cash directly and to only withdraw additional cash from the bank if their realized liquidity demand is large enough. This feature allows the model to neatly distinguish between bank reserves and currency held by the public.
box, while the origin for the type $L$ agent is the northeast corner. The dimensions of the box are determined by the bank’s portfolio choice: holding more money and less capital would make the box wider and shorter; holding more capital and less money would have the opposite effect. The budget line from Figure 2 is displayed in this box. As shown in the figure, the type $H$ agent chooses to consume relatively more of $c_1$ and the type $L$ agent chooses to consume relatively more of $c_2$. When the bank sets its portfolio according to (3), both agents’ indifference curves will be tangent to this budget line at precisely the point $c^*$.  

1.4 Banking II: Insurance

Interestingly, $c^*$ is not the best allocation that a bank can implement in the simple model I have presented here. The first-best allocation in this model maximizes each agent’s period 0 expected utility

$$\frac{1}{2}(\theta_H u(c_{1,H}) + v(c_{2,H})) + \frac{1}{2}(\theta_L u(c_{1,L}) + v(c_{2,L}))$$

subject to the feasibility constraints. It is straightforward to show that the solution to this problem sets

$$c_{1,H} > c_{1,L} \quad \text{and} \quad c_{2,H} = c_{2,L}.$$
In terms of the Edgeworth box in Figure 3, the first-best allocation corresponds to a point like $a$, which divides the available amount of $c_2$ evenly between the two agents but gives a larger share of the available amount of $c_1$ to the type $H$ agent. This outcome clearly differs from the equilibrium allocation $c^*$. The first-best allocation provides agents with liquidity insurance, that is, insurance against the realization of the liquidity preference shock $\theta_i$. The most desirable insurance arrangement involves equating the marginal utility of consumption across agents. Given the form of preferences assumed here, equating marginal utilities involves equalizing consumption at $t = 2$ across all agents but having agents who value consumption at $t = 1$ differently consume different amounts.

It is readily apparent that this allocation is not incentive feasible, however; type $L$ agents would strictly prefer the consumption bundle designed for type $H$ agents. A more relevant benchmark when types are private information is the constrained-efficient allocation, which maximizes (4) subject to both feasibility and the incentive compatibility constraints

$$\theta_i u(c_i) + v(c_i) \geq \theta_i u(c_j) + v(c_j) \quad \text{for } i, j \in \{H, L\}.$$  

These constraints are represented by the curves labeled $IC_L$ and $IC_H$ in Figure 3; the set of allocations satisfying both constraints is the area between the curves in the lower-right quadrant of the box. The solution to this problem is an allocation like the point $b$, which falls along the incentive compatibility constraint for Type $L$ agents. Again, this outcome is clearly different from the equilibrium allocation $c^*$.

Figure 3 demonstrates that an optimal banking arrangement in the simple model presented here is necessarily different from the demand-deposit scheme described above. Agents’ indifference curves are not tangent at the point $b$, reflecting the fact that the incentive compatibility constraint for type $L$ agents is binding. As a result, this allocation cannot be implemented using a standard demand-deposit contract; some other, nonlinear contract would be required. One possibility would be for a bank to offer its depositors a menu with only two choices: a depositor can withdraw $c_{1,H}^b$ in period 1 and $c_{2,H}^b$ in period 2, or she can withdraw $c_{1,L}^b$ in period 1 and $c_{2,L}^b$ in period 2.

Bencivenga and Camera rule out this type of insurance in their model by assuming that banks offer standard demand deposit contracts. However, this assumption appears to be without any loss of generality in their setting because of the form of agents’ preferences. Following Lagos and Wright (2005), agents’ utility in the centralized market is assumed to be quasi-linear. This assumption is generally made to maintain tractability in the model by ensuring that heterogeneity is temporary; agents with

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3. In addition, the dimensions of the Edgeworth box associated with the first-best allocation will generally be different from those associated with the equilibrium allocation $c^*$. The two allocations are depicted together in the same box in Figure 3 for illustration purposes.

4. See Jacklin and Bhattacharya (1988) for a detailed analysis of a version of this type of model in which the return on the “capital” investment is random.
different trading histories and wealth levels will nevertheless desire the same portfolio in the next centralized market. However, in the present setting, the assumption may have the additional (and perhaps unintended) consequence of removing the demand for liquidity insurance.

To see the effects of quasi-linear preferences in our simple model, suppose that the function $v$ in (1) is linear rather than strictly concave. In this case, the first-best allocation is no longer uniquely defined. Instead, any allocation along a vertical line segment in the Edgeworth box in Figure 3 generates exactly the same level of expected utility. Different points along such a line impose different levels of risk on the agents regarding their period 2 consumption. When the function $v$ is linear, however, agents are perfectly indifferent about facing this risk. The equilibrium allocation $c^*$ will then correspond to one of the points on the vertical line segment associated with the set of first-best allocations. Note that $c^*$ satisfies the incentive compatibility constraints by construction, since agents are allowed to choose how much to withdraw in each period.

In other words, when preferences are quasi-linear, there is no welfare loss from requiring banks to offer standard demand-deposit contracts in this simple model. In this case, the only role of banks is to ensure the efficient allocation of cash balances across agents. When preferences are strictly concave, in contrast, the efficient banking arrangement will also have an insurance component and will require a different type of banking contract. The Bencivenga–Camera model focuses on the cash-allocation role of banks and shows how this role can be studied in a model where money facilitates decentralized trade. In future work, it would be interesting to see if a liquidity-insurance role for banks could also be introduced into this class of monetary models in a tractable way, and how this liquidity insurance role might alter or reinforce the results from the Bencivenga–Camera model.

2. CONCLUDING REMARKS

The recent financial crisis has highlighted the need for macroeconomic and monetary analysis to take more explicit account of the roles played by financial institutions. A sizable effort is currently underway to integrate financial institutions into macro/monetary models. The paper by Bencivenga and Camera represents an important step forward in this agenda. It shows how banks that efficiently allocate money balances across agents can be incorporated into a model of decentralized trade, and how the resulting model can be used to study the effects of central bank policies such as paying interest on bank reserves.

A significant part of this research agenda involves finding ways to incorporate heterogeneity (in preferences, incomes, trading opportunities, etc.) in a way that

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5. Similarly, the solution to planner’s problem in section 3 of Bencivenga–Camera does not pin down the complete allocation; it determines the total number of hours worked in the centralized market in each period, $h_{2t}$, but not the distribution of those hours across agents.
generates a role for financial institutions, while at the same time maintaining tractability of the model. Bencivenga and Camera follow Lagos and Wright (2005) in using quasi-linear preferences to make heterogeneity in the model temporary, since agents with different histories will choose the same portfolios and actions going forward. This fact greatly reduces the dimension of the state space of the model and allows it to retain the basic features of a representative-agent framework.

All simplifying assumptions come at a price, of course. Like any model, the Lagos–Wright framework is designed to address certain types of issues and not others. The simple model I have presented in this discussion highlights some restrictions that may come with the quasi-linearity assumption when banks are introduced into the model. In particular, when preferences are quasi-linear, the demand for liquidity insurance that has been the focus of much of the banking literature following Diamond and Dybvig (1983) disappears. The liquidity-allocation role of banks remains present, of course, and the authors have done an excellent job of studying that role here. Going forward, it will be important to incorporate the insurance function, as well as other roles that banks play, into macro/monetary models. Bencivenga and Camera have provided a useful first step in this agenda and their model provides an excellent starting point for future work.

LITERATURE CITED


