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Summer Workshop on Money, Banking, Payments and Finance: An Overview

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Abstract

The 2010 Summer Workshop on Money, Banking, Payments and Finance met at the Federal Reserve Bank of Chicago this summer, for the second year. The following document summarizes and ties together the papers presented.

1 Introduction

The annual Summer Workshop on Money, Banking, Payments and Finance met again in August 2010. The theme once again was on institutions that facilitate the exchange process, including money, credit, banks, asset markets, and related topics. Most of the work uses the branch of economic theory recently dubbed New Monetarist Economics in surveys by Stephen Williamson and Randall Wright (2010a, 2010b), and extensively described in the book by Ed Nosal and Guillaume Rocheteau (2011). The goal in this framework is to take microfoundations of the exchange process seriously, as opposed to resorting to ad hoc shortcuts (such as imposing cash-in-advance constraints or inserting money into utility functions), or simply ignoring institutions meant to facilitate exchange (as in most New Keynesian models). This field of research is extremely active and many papers have been making progress in terms of our understanding of basic theory, our development of applications, including policy analysis, and our understanding of the evidence.

This year 32 papers were presented. These can be broadly grouped into six broad topics: liquidity, which is the ability to quickly buy or sell assets (or other objects) with a short delay and at a low cost; financial intermediation, with a focus on the roles of banks; international economics, which examines issues related to money, capital, liquidity and exchange rate determination in an international

context; history, which tries to understand interesting economic episodes in the past through the lens of modern theory; information, which involves modeling information asymmetries that characterize, for example, over-the-counter markets and financial markets, in general; and theory, which involves work on relatively deep issues related to money, banking, payments or finance. Here we summarize and to some extent try to consolidate the individual contributions.

2 Liquidity

The last two U.S. recessions were preceded by rapid increases, followed by abrupt collapses, in some asset prices. These events have suggested to many that asset prices can rise above levels justified by fundamentals, and that price corrections can trigger or amplify economic fluctuations, with important consequences for the macroeconomy. When and how can economic models generate this type of asset price behavior as an equilibrium outcome? This issue is nontrivial since generating such asset price dynamics is not easy in standard models. In "Liquidity and Asset Price Dynamics," Guillaume Rocheteau and Randall Wright study an economy with an essential role for liquid assets. The model can generate multiple stationary equilibria, across which asset prices, participation, stock market capitalization, output and welfare are positively related. Even when fundamentals are deterministic and time invariant, there can be a variety of non-stationary equilibria. This includes equilibria with price trajectories that resemble bubbles growing and bursting, as well as periodic, chaotic, and stochastic (sunspot) equilibria with recurrent market crashes. The issue of optimal liquidity provision is also examined. This paper extends the class of models we can use to help understand dynamic asset markets and the role of liquidity.

During financial crises, many asset prices plummet, destroying their liquidity provision function at the worst time. These fire sales appear to be at the core of the amplification mechanism and credit crunch observed in some crises. How can this occur in deep financial markets, such as those in the U.S. where a large number of potential buyers should have the resources to arbitrage fire sales? In "Fire Sales in a Model of Complexity," Ricardo Caballero and Alp Simsek propose a model in which the answer builds on the idea that complexity becomes a central concern during crises. The basic structure of their model is that of a financial network that is susceptible to contagion and cascades. During normal times, banks only need to understand the financial health of their trading partners, which they can learn at low cost. In contrast, when a significant problem arises in a part of the network, and the possibility of cascades arises, it is not enough to be informed about these partners. It is also important to learn about the health of their trading partners. As conditions deteriorate, banks must learn about the health of the trading partners of the trading partners of their trading partners, and so on. Eventually, the problem becomes too complex to fully figure out, which means banks face significant uncertainty. This rise in uncertainty makes relatively healthy banks, and hence potential asset buyers, reluctant to buy. This is help in understanding how

liquidity in the market can quickly vanish.

A sharp decline in the volume of new issuances in the U.S. secondary loan market has resulted in a variety proposals intended to restore the "normal" functioning of this market. In "Adverse Selection, Reputation and Sudden Collapses in Secondary Loan Markets," V.V. Chari, Ali Shourideh, and Ariel Zetlin-Jones analyze why new issuances might abruptly collapse. The main economic function of the secondary loan market is to allocate originated loans to individuals and institutions that have a comparative advantage in holding or managing these loans. This function can be disrupted by informational frictions. In particular, an adverse selection problem arises since loan originators differ in their ability to originate high-quality loans, and are better informed about this ability than potential purchasers. Reputational considerations can either ameliorate or intensify this problem. The model has fragile outcomes in which sudden collapses in the volume of new issuances are associated with increased inefficiency. Reductions in collateral values worsen the adverse selection problem and induce some potential sellers to hold on to their loans. Reputational incentives induce a large fraction of potential sellers to hold on to their loans rather than sell them in the secondary market. As a result, a small reduction in collateral value can cause a large number of originators to hold their loans, leading to a collapse in new issuances. The authors discuss a variety of interest rate and loan purchase policies.

In a similar vein, the crisis has forced governments or central banks to heavily intervene in financial markets that were impaired by risk and uncertainty. In "Market Freeze and Recovery: Trading Dynamics under Optimal Intervention by a Market-Maker-of-Last-Resort," Jonathan Chiu and Thor Koeppl study how a financial market where trading has ceased reacts to intervention by a large player. They analyze the optimal design of intervention as a crisis is unfolding. In the context of a search model with adverse selection, they demonstrate that trading of a financial asset can cease when its average quality drops sufficiently, or when trading frictions increase sufficiently. A large player like a central bank can re-establish trading if he removes a large quantity of bad assets. This involves assuming losses. They show that such a player does not have to intervene immediately: an announcement today of future intervention can cause markets to rebound. This announcement effect gives rise to a trade-off between the size and timing of interventions. The optimal policy balances the cost of transfers against the cost of illiquidity. If the former are small, it is optimal to ensure that markets function continuously. This is achieved by intervening immediately, but at a minimum scale. When the costs of transfers increase, it is better to delay intervention and increase its size. Furthermore, if the central bank is required to maintain continuously functioning markets, they show that the optimal policy is to intervene immediately after the shock, but at the minimum scale that is required to resurrect the market. This is in stark contrast to the literature that analyzes optimal market making in the face of pure liquidity shocks.

If financial market participants lack commitment, capital can be valued for its ability to facilitate intertemporal trade. For example, capital is frequently used as collateral in support of debt. Most of the time, private instruments work

tolerably well in facilitating payments. There are recurring episodes, however, when the system is disrupted by a decline in the value of capital. In "Money and Capital in a News Economy," David Andolfatto and Fernando Martin interpret such episodes as the consequence of "bad news" that lowers the conditional forecast of future capital returns. Government policy designed to subsidize capital in depressed conditions has an ambiguous impact on welfare. On the one hand, such a policy eases credit conditions. On the other hand, it promotes overaccumulation of capital goods that are used for collateral. They also investigate the desirability of other interventions in the payments system. The model suggests the desirability of government money or debt for use in payments. While this conclusion is not new, the rationale offered is novel. In a stochastic economy with limited commitment, even risk-neutral traders have a preference for assets that exhibit "value preservation" over short horizons. One benefit of government money or debt is that its value is not tied directly to any underlying capital object, so it may be less sensitive to "news." This suggests that government debt is valued in the payments system because it may retain its value in depressed conditions.

During the recent financial crisis, policy makers introduced a number of new tools to address the apparent lack of liquidity in financial markets. In "Optimal Liquidity Policy," Jennifer Huang and Jiang Wang construct a simple theoretical framework to examine issues associated with policy intervention. In their environment liquidity provision is inefficient in the market equilibrium, in both an ex ante and ex post sense. The inefficiency arises because agents are unable to profitably capture the entire externality associated with liquidity provision. They demonstrate that policy interventions that resemble those that we saw during the recent crisis often have limited or undesirable effects. They propose a constrained optimal liquidity policy.

3 Financial Intermediation

How are publicly- and privately-provided liquidity important for exchange in financial markets? How does monetary policy matter for inflation and real allocations, through its effects on exchange and intermediation? In "Liquidity, Financial Intermediation, and Monetary Policy," Stephen Williamson addresses these questions in a model that integrates elements of received banking and monetary theory. In contrast to standard approaches, open market operations need not be neutral, even in the long run. This is because a one-time open market purchase of nominal government debt reduces the supply of public liquidity backing intermediary claims used in financial markets. The real interest rate falls, reflecting asset scarcity, and this increases intermediary lending and output. The model shows how fiscal policy (active or passive) matters, and illustrates how the costs of operating a currency system matter for the determination of an optimal inflation rate. Some examples show the effects of a financial crisis on the economy, and how policy should respond. Monetary policy works quite differently when banks are holding excess reserves. In that case, the interest

rate on reserves determines all other interest rates, and open market operations are irrelevant. A liquidity trap can occur for any inflation rate, given the appropriate monetary policy, not just at the Friedman rule. This is a fine example of getting new insights about critical policy issues by using modern monetary theory.

In related work, "Liquidity, Asset Prices, and Credit Constraints," by Ying-Syuan Li and Yiting Li, the implications are examined for asset prices and borrowing in an economy with limited commitment, enforcement and record keeping. Banks provide a socially beneficial role by channelling funds from people with idle liquidity to those with needs to finance consumption. Because banks offer loan contracts that allows agents to borrow only as much as they have an incentive to repay, credit constraints endogenously emerge. The relationship between asset prices, aggregate liquidity and allocations are characterized. An asset will command a liquidity premium when credit constraints bind, and the premium is higher when credit rationing is more severe. Monetary policies can influence macroeconomic outcomes through the credit channel, and the precise effects depend on the technology to deter default. If exclusion from future credit is feasible, aggregate liquidity and output may rise with inflation, because inflation raises the cost of losing the access to future credit. Even though the asset price is reduced by inflation, liquidity may be increased because of higher loan-to-value ratios. The asset price is reduced by inflation since money and real assets, which are used as collateral, are complements. This is in contrast to most of the literature, in which money and other assets are substitutes. This paper thus greatly enhances our understanding of the relationship between money and asset prices.

Continuing on the theme of intermediation, most theories of banking crises focus on the case where contracts are written in real terms, so "liquidity" means the availability of a physical good that can be used for consumption or investment. There is, therefore, a real opportunity cost to providing liquidity to the financial system. In practice, however, financial contracts are almost always written in nominal terms. The possibility of nominal contracts potentially makes a significant difference because it means that the central bank can costlessly create money to deal with a crisis. In "Money, Financial Stability and Efficiency," Franklin Allen, Elena Carletti and Douglas Gale use a standard banking model but with nominal rather than real contracts. They show that the combination of nominal contracts and a central bank that accommodates commercial banks' demand for liquidity leads to efficiency. This implies there are no financial crises even when liquidity demands are high or asset returns are low. The efficiency result holds with aggregate and idiosyncratic liquidity shocks, as well as aggregate and idiosyncratic uncertainty about asset returns. Although the assumption of nominal contracting perhaps requires some more justification, it is important to know the implications.

In "Liquidity Transformation and Bank Capital Requirements," Hajime Tomura presents a dynamic general equilibrium model of banking, where liquidity transformation and bank capital requirements arise endogenously. New real assets are produced from goods, and the fraction of agents that can produce them

must sell existing assets in a secondary market to finance purchases of goods needed to produce new assets. Adverse selection in the secondary market means potential producers of new assets are discouraged from selling high-quality assets. As a result, they purchase and invest less. The market's undervaluation or illiquidity of assets leads to a demand for liquid assets. Banks can meet this demand since they can issue liabilities backed by assets from the secondary market. Bank liabilities are priced fairly since the idiosyncratic qualities of real assets held by a bank average out. The existence of these liabilities increases liquidity. However, the secondary market price for real assets is reduced. The model shows that if the business cycle is driven by productivity shocks, then fluctuations in the capital-asset ratio of banks are pro-cyclical, but they are counter-cyclical if a rise in heterogeneity of asset quality increases the illiquidity of real assets in the competitive secondary market for real assets. This work is pointing us in the right direction in terms of understanding secondary asset markets.

4 International

Several papers applied modern monetary theory to study international economic issues. For example, in response to a global dollar shortage in the recent crisis, the Fed injected dollar liquidity into the international financial system. Empirical studies of the success of these efforts have yielded mixed results because it is difficult to disentangle the effects of policy from those of news about fundamentals. In "Dollar Illiquidity and Central Bank Facilities During the U.S. Sub-Prime Crisis," Andrew Rose and Mark Spiegel develop a model of dollar illiquidity. In their model, assets are valued for both their returns and liquidity services. When the liquidity of an asset declines (say, toxic American mortgage-backed securities), the model predicts that the dollar appreciates since the demand for close substitutes increases through a "flight to liquidity." The theory suggests that nations with more exposure to the US are likely to be more sensitive to global capital injections, such as the term auction facilities conducted by the ECB and others. Although the preliminary evidence is mixed, some auctions appear to yield results in line with their theory.

Another issues in international economics is this. Even though low inflation rate international currencies are increasingly available in most economies, domestic currencies remain the dominant means of payment in most countries. This observation seems to contradict the literature on currency competition, which predicts that in absence of transaction costs agents will use the less inflationary currency. In "Inflation, Debt Enforcement and Currency Competition," Mariana Rojas Breu constructs a framework in which higher inflation currencies are used despite the availability of a lower inflationary currency and the absence of transactions costs. The model is a standard monetary economy with banks, where a key assumption is that debt enforcement is not perfect. Under certain conditions, the inflation rate of a currency in which debts are denominated may function as a commitment device. A higher inflationary currency can be used in

equilibrium since the punishment for defaulters (who avoid market transactions) will be higher if the currency in which they borrow is more inflationary. That is, there will be a smaller benefit associated with defaulting on debt that is written on the more inflationary currency. Lending agents anticipate that borrowers are able to better commit to repaying their loans the more inflationary is the currency. As a result, banks are willing to hold a more inflationary currency. This is a novel spin on a topical issue.

A related issue is this. Over the past decade, OECD countries have held nearly three quarters of their wealth in domestic assets. This is at odds with standard frictionless models that predict risk averse agents will insure away country-specific risks by holding a portfolio of international assets. A large literature has tackled this "home bias" puzzle by examining frictions that limit the ability of agents to diversify internationally. In "Asset Liquidity and Equity Home Bias," Thanasis Geromichalos and Ina Simonovska attempt to rationalize this puzzle through a mechanism that links home bias to liquidity. The concept of asset liquidity arises when assets can serve a duel role: they are claims to future consumption and means of payments. If there are better opportunities to trade in domestic than foreign decentralized markets, agents will have a greater demand for home assets. Since agents hold more domestic assets, they bring more of these assets to domestic markets and exchange them for larger quantities of goods. Hence, asset home bias also generates consumption home bias, as in the data. The authors have a promising framework for future work in the area.

In "Goods Market Frictions and Real Exchange Rate Puzzles" Qing Liu develops a two-country dynamic search model with fully flexible price. His approach deviates from the literature, which relies on the interaction of nominal price rigidities and monetary shocks. His goods market is decentralized and modeled using random bilateral matching. Search frictions in markets generate a differential in a household's valuations of two currencies, and results in a deviation from the law of one price at both the disaggregate and aggregate levels. Quantitative results suggest that deviations from the law of one price contribute to the majority of the fluctuations in exchange rates observed in the data. Moreover, the model performs well quantitatively with respect to two other stylized facts: changes in real exchange rates are highly persistent; and there are systematic changes in the volatility of real exchange rates when there is a switch of exchange rate regimes. This is another promising framework for future work in international economics.

Similarly, in "Money, Capital and International Exchange Rate Fluctuations," Pere Gomis-Porqueras, Timothy Kam and Junsang Lee examine whether a flexible price, two-country, search model of money can account for empirical regularities in U.S. real and nominal exchange rate dynamics. In the data, the real and nominal exchanges rates are more volatile than GDP, are highly persistent, and are highly positively correlated. The authors use a two-country version of the Lagos-Wright model, where capital is a productive input for sellers in the decentralized market. There are two mechanisms at work that help amplify and propagate international shocks: the monetary friction, and capital

accumulation. The monetary friction can be controlled by introducing an exogenous probability that agents in decentralized trade may be in one two kinds of trades, anonymous monetary trades or monitored credit trades. If the monetary friction is shut down by having only credit trades, the authors show that the model cannot account for the facts on exchange rates. However, if a small proportion of trades are anonymous—so agents must use money—then aggregate relative prices are relatively non-volatile and persistent. This contributes to the excess volatility and persistence in the real and nominal exchange rate. Thus, without exogenous price-stickiness, the model rationalizes the correlation between real and nominal exchange rate.

In "Heterogeneity and the Welfare Cost of Inflation: An International Perspective," Paola Boel quantifies the welfare cost of anticipated inflation in a model with equilibrium dispersion in wealth and earnings. The model is calibrated to several OECD economies, including Australia, Austria, Canada, France, Italy, Spain and the U.S. In all economies, except Australia, a representative agent would give up only a fraction of 1% of consumption to avoid 10% inflation. Even if inflation does not generate large losses in societal welfare, she finds that in all countries considered, inflation has significant redistributive effects. Moreover, such redistributive effects vary depending on the financial assets present in the economy. If money is the only asset, then inflation hurts the wealthier agents, while those poorer benefit from it. The opposite is true if agents can insure against consumption risk with other assets. This is a nice further step towards understanding the role of monetary policy not just in the U.S. but in other countries.

5 History

Several papers look at money and financial institutions from the historical perspective. In "How Amsterdam Got Fiat Money," Stephen Quinn and William Roberds investigate the system introduced by the Bank of Amsterdam in 1683. Using data from the Amsterdam Municipal Archives, they partially reconstruct changes in the bank's balance sheet from 1666 through 1702. Their calculations show that the Bank of Amsterdam, which was founded in 1609, engaged in two archetypal central bank activities—lending and open market operations—both before and after its adoption of a fiat standard. These activities were made possible by the bank's (near) monopoly on large-value payments within the city of Amsterdam. After 1683, however, the bank was able to conduct more aggressive policy interventions. To ease seasonal credit pressures, the bank routinely extended large loans to the East India Company, and it also bought and sold significant quantities of precious metal in order to stabilize the value of its money. The bank's successful management of a fiat standard foreshadows later developments in the history of central banking.

Prior to the U.S. Civil War, several states established bank liability insurance schemes of two basic types. One was an insurance fund, in which member banks paid into a state-run fund that would pay losses of bank creditors. The

other was a mutual guarantee system, in which survivor banks were legally responsible the liabilities of any bank that became insolvent. In "Bank Liability Insurance Schemes Prior to 1865," Warren Weber argues that both schemes did well at insuring bank creditors, but neither prevented bank panics. In fact, bank failure rates were somewhat higher for banks that were part of these schemes. The experience with these schemes shows that regulatory incentives matter for controlling moral hazard, obviously an important message for contemporary economies as well. The schemes that provided the most control of moral hazard were those that had a high degree of mutuality of losses borne by all banks participating in the scheme.

In "Mechanism Design and Commodity Money," Richard Dutu and Ching-jen Sun propose a model where profit-maximizing mints design menus of coins for buyers. Buyers purchase coins from mints and use them to buy goods from sellers. Coins differ in two dimensions: by their weight (or fineness), which reflects an intrinsic quality, and by their seigniorage fee (the mint's revenue). Two different market structures are examined: In one, the supply of coins is controlled by a monopoly, while in the other it is determined by in competitive market. The model offers answers to several puzzles associated with commodity money systems, such as the lack of small change, the unappealing denomination structure and variations in seigniorage rates across coins. For example, when the mint has a monopoly over the supply of coins, they show that the menu of coins offered to buyers is characterized by inefficiently small low-denomination coins and by seigniorage rates that are higher on small coins. When the proportion of low-valuation buyers is too small, it is optimal for the mint to offer large coins only, hence, the lack of small change. Like the rest of these papers on historical issues, this one is useful for thinking about modern economies as well.

6 Information

The next group of papers concern informational frictions. This is potentially a very important area of research on asset markets, where it can be difficult for traders to know the quality of some securities. Especially since the recent financial crisis, it seems necessary to understand how asset markets function with adverse selection. Veronica Guerierri, Robert Shimer and Randall Wright, in "Equilibrium in Dynamic Asset Markets" assume buyers may be less informed about the return on an asset. This may affect the price of assets, and moreover, informational frictions imply that it may take a longer time to trade, which means liquidity is affected. A big issue that comes up in modeling asset markets with private information is this: what mechanism determines the terms of trade? The authors use price posting with directed search, also known as competitive search equilibrium. They first extend their earlier work on competitive search equilibrium with adverse selection from static to dynamic environments. They then use the model to analyze equilibria in asset markets with private information. A key insight is that higher quality assets must trade with a lower probability, or must be less liquid, because this is the way to effectively screen

out seller with lower quality assets.

A related paper is "Trading Dynamics in Decentralized Markets with Adverse Selection," by Braz Camargo and Benjamin Lester. They also study a dynamic, decentralized market with asymmetric information and interdependent values between buyers and sellers. In the model, buyers and sellers are randomly matched each period, and sellers have private information about the quality of their goods. If trade occurs, then the pair exits the market; otherwise, they remain in the market and are randomly matched with new trading partners in the following period. Since the composition of goods remaining in the market at each point in time is endogenous, a key component of an individual's strategy is whether to trade now or to wait for conditions to improve. The model delivers a stark relationship between the severity of the information frictions and market liquidity, measured by the expected amount of time it takes to a sell high-quality goods. This framework can be used to understand how asymmetric information has contributed to the recent financial crisis, to describe how such markets might clear over time on their own, and to study the effects of government intervention.

Anonymity plays an important role in making money essential. But anonymity can also constrain choices available to the monetary authority, an aspect of monetary policy implementation that has not been fully examined in the literature. In "Costly Recordkeeping, Settlement System and Monetary Policy," Pere Gomis-Porqueras and Daniel Sanchez study the implications of anonymity for optimal policy. They assume that the government lacks the technology to verify agents' identities and their private trades. As a result, it must rely on the public information that is voluntarily created, at a cost, by the private sector in order to implement monetary policy. If not all private transactions are publicly reported, then the injections of fiat money will be asymmetric. In this case, the socially efficient allocation cannot be implemented by any incentive-feasible policy. The optimal monetary policy for an economy with a low recordkeeping cost and a large number of public transactions has positive inflation and nominal interest rates. Like the other papers in this section, this one helps us understand better some important aspects of policy making in an uncertain world.

Similarly, in "Money and Credit: The Role of the Informal Sector," Pere Gomis-Porqueras, Adrian Peralta-Alva, and Chris Waller use a search model of monetary exchange to study sellers' decision to either be paid in cash or use credit. Since credit trades are recorded, the government can levy taxes. Cash avoids any record of the transaction and, hence, taxation. A seller's choice is really one of being anonymous or not. In the absence of distortionary taxes, only a credit equilibrium exists, since money is costly to hold. If taxes are distortionary, then a monetary equilibrium will exist for sufficiently low inflation rates. Credit will be used only when inflation rates are high. If the preferences of agents are heterogeneous, then money and credit can coexist, with both being used in some transactions.

In "Information in a Monetary Search Model," Mei Dong and Janet Hua Jiang study the role of information transparency in a monetary model. There are two types of buyers in the economy: one type is fully informed about the

price postings by each seller, and the other type is partially informed, only knowing the aggregate distribution of price postings. The effect of information transparency can be analyzed in cases. When information transparency is low, increasing transparency results in higher real price and worsens the terms of trade for buyers (and for sellers). With medium information transparency, higher transparency causes real prices to decrease and the terms of trade for buyers to improve. When the fraction of fully informed buyers is high, increasing transparency does not effect the economy. Costs associated with holding money or with ex ante investments have important implications about the effect of information transparency.

Some recent monetary economics literature studies counterfeiting, but most the papers do not have counterfeiting occurring in equilibrium. This seems contrary to what we observe, where counterfeiting of bank notes in some countries has recently experienced rapid increases. In "Counterfeit Quality and Verification in a Monetary Exchange," Ben Fung and Enchuan Shao examine conditions under which counterfeiting can occur and, when it does, how policy including anti-counterfeiting measures affects it. The authors use a competitive search environment, where sellers post offers and buyers direct their search based on posted offers. When sellers are uninformed, their offers are pooling and, as a result, buyers are able to extract rents by using counterfeits. Counterfeit notes can coexist with genuine notes. Since the interaction between sellers' verification decisions and counterfeiters' choices of counterfeit quality is explicitly modeled, the authors can study how policies affect counterfeiting.

7 Theory

There were several papers on pure monetary theory. In "A Monetary Theory with Non-Degenerate Distributions," Guido Menzio, Shouyong Shi and Hongfei Sun construct a tractable directed-search model with a non-degenerate distribution of money holdings. This is useful since, obviously, in actual economies some individuals hold more money than others. The rationale underlying a range of policies designed for reallocating liquidity among individuals depends on the distribution of money holdings. However, much monetary theory has abstracted from this non-degenerate distribution for reasons of tractability. Menzio et al. in their model have a distribution of money holdings that is non-degenerate. This distribution affects individuals' decisions indirectly through a one-dimensional variable—the wage rate. This relationship drastically reduces the state space for individuals' decisions, and makes the model relatively tractable. In the equilibrium, buyers follow a stylized spending pattern over time, and the money distribution has a persistent wealth effect.

Going back to the original Kiyotaki-Wright model of commodity money, it is well known that this framework has a large multiplicity of dynamic equilibria. In "Period Length and the Set of Dynamic Equilibria with Commodity Money," Ezra Oberfield and Nicolas Trachter analyze the role that the length of a period plays in determining the extent of this multiplicity. They adapt the

basic model so that they can vary period length without altering the fundamentals of the economy. The symmetric version of their model is characterized by multiplicity of equilibrium and complicated dynamics when the period length is strictly positive. The continuous time limit of their setup, however, has a unique symmetric equilibrium. They show that as the time period shrinks, the sets of possible equilibrium payoffs, local averages of strategies played, and dynamic paths of the economy all converge uniformly to those of the unique equilibrium in the continuous time limit. Hence, when the relevant time period is short, all equilibrium paths are well approximated by that of the continuous time limit.

In "Endogenous Credit Cycles," Chao Gu and Randall Wright study the fluctuations in credit markets with limited commitment. Agents are free to renege on debt obligations, but those who are (probabilitistically) caught are punished by exclusion from future credit. This gives rise to an endogenous credit limit. When the credit limit is binding, collateral can help mitigate the commitment problem, but does not completely solve it. Two mechanisms for the credit are examined, Nash bargaining and Walrasian pricing. For both mechanisms, the model can display exotic dynamic equilibria, including deterministic or stochastic cycles, and chaotic dynamics. In some equilibria, credit conditions change over time, even though fundamentals are deterministic and stationary. Such changes are self-fulfilling prophecies. Also in these equilibria, credit limits may bind in some periods but not others, illustrating how it is possible to generate credit freezes. It is also argued that pure credit models resemble monetary models in some interesting ways, especially in the sense that beliefs play an important role in determining equilibria.

In "Money in a Model of Prior Production and Imperfectly Directed Search," Adrian Masters provides an analysis of how inflation affects behavior and welfare when goods must be produced prior to the point of sale. This implies that sellers have to make inventory decisions based on expected market conditions while their potential customers decide how much cash to bring to the market based on expected trading opportunities. Customers' have preference shocks that are private information, and sellers in equilibrium charge everyone the same price. If a buyer likes the good, but not sufficiently to pay the seller's posted price, they may not trade even though there are positive gains from trade. Monetary policy can mitigate this inefficiency: a departure from the Friedman rule can improve matters. In this case, inflation erodes the value of money, which means buyers become less picky and prefer to purchase today rather than wait until tomorrow. This effect of inflation is reminiscent of the so-called hot potato effect. This paper usefully connects several earlier analyses in one framework.

The next theory paper is motivated by empirical studies that suggest the price elasticity of demand for a given brand is primarily determined by changes in the number of customers purchasing that product, rather than changes in the quantity purchased by each customer. In "Inflation and Price Competition" Boragan Narajabad develops monetary model with directed-search and endogenous search intensity to explore the implications of monetary policy for price distributions, output and average productivity. The are two inefficiencies: less productive producers produce and producer prices exceed marginal cost.

Although a little inflation can increase output and improve average productivity, it raises the welfare of the lucky consumers—those who are matched with productive producers—while lowers that of unlucky consumers—those who are matched with unproductive producers

A related paper is "Optimal Monetary Policy: Distribution Efficiency vs. Production Efficiency," by Haitao Xiang. The paper studies the trade-off between distribution and production effects of monetary policy when there are idiosyncratic liquidity shocks. In absence of risk-sharing arrangements, monetary policy serves to provide ex post insurance to smooth consumption. When liquidity shocks are observable, a type-contingent money transfer can redistribute purchasing power among consumers desirably; when liquidity shocks are unobservable, an illiquid bond policy helps. Both policies have positive distributional effects, but the resulting inflation has a negative effect on production. The author provides a sufficient condition under which social welfare can be improved by an inflationary monetary policy, i.e., if consumers are sufficiently relative risk averse, the trade-off between distributional efficiency gains and production efficiency losses results in net improvement.

In "The coordination value of monetary exchange: Experimental evidence," Gabriele Camera and Marco Casari uncover a new behavioral foundation for why money promotes impersonal exchange. In experiments, subjects can cooperate by intertemporally exchanging goods with anonymous opponents they meet at random. Indefinite repetition can support multiple equilibria, from full defection to the efficient outcome. Introducing the possibility to hold and exchange intrinsically worthless "tickets" that resemble fiat money can help equilibrium selection. Monetary exchange facilitates coordination on cooperation and redistributes surplus from defectors to cooperators. These findings offer new insights about cooperation in groups of individuals involved in long-term interactions and contributes to a large literature on repeated games. Experiments such as these provide some evidence to assess the validity of such theories. In addition, this study contributes to an experimental literature on money. In contrast to previous experiments, money here has neither intrinsic nor redemption value.

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