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## Introduction to the macroeconomic dynamics: Special issues on money, credit, and liquidity

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Federal Reserve Bank of Chicago

**Introduction to the *Macroeconomic Dynamics*: Special issues on money, credit, and liquidity**

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# Introduction to the *Macroeconomic Dynamics* special issues on money, credit, and liquidity

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## Abstract

We motivate and provide an overview to New Monetarist Economics. We then briefly describe the individual contributions to the Macroeconomics Dynamics special issues on money, credit and liquidity.

## 1 Introduction

This two-volume special issue of *Macroeconomic Dynamics* contains a collection of papers on money, credit, liquidity, banking, payments, asset pricing, and related topics. The contributions not only share general substantive interests, but also utilize a common method that we obviously endorse. This method involves an effort to take seriously the microeconomic foundations of models used to study the topics under consideration. It is clear to us that not all practitioners adopt this approach and that much work in macroeconomics is not sufficiently concerned with the microeconomic details behind institutions such as money, credit, or intermediation.<sup>1</sup> In many popular models, money is introduced by using some ad hoc short cut, say by putting

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<sup>1</sup>Appeals for better microfoundations in monetary economics go back a long time. Examples include Hicks (1935) and some of the papers, including the introduction, in the volume of Kareken and Wallace (1980). See also Wallace (1998,2001,in press) for updated discussions of these issues. The general approach we are advocating here has been dubbed *New Monetarist Economics* in two papers by Williamson and Wright (2010,in press), which discuss methodological issues, and survey the literature, respectively. An extended textbook treatment of the framework with a wide variety of applications can be found in Nosal and Rocheteau (in press). Although we are obliged to say a

real balances into utility or production functions, or by imposing a cash-in-advance constraint. Indeed, sometimes other assets, including government bonds or commercial bank reserves, are also inserted into utility or production functions. Moreover, in many of the models that dominate contemporary discussions of monetary policy at central banks, there is no money at all, and nothing that resembles intermediation in any interesting way.<sup>2</sup>

The reason many economists either ignore institutions like money, or slip them in with short cuts, is this: they do not take seriously the nature of the *process* of exchange. Following classical general equilibrium theory, agents do not trade with each other, but trade only against their budget constraints. Any bundle that is worth no more than the value of one's endowment is available, with no discussion of how it is to be acquired. Everyone worth his salt understands that there is no role in Debreu's frictionless paradigm for money, intermediation, or anything else that facilitates the process of exchange since this process is not part of model.<sup>3</sup> Unless one introduces explicit frictions, therefore, short cuts are needed to get money and related institutions into the discussion. These short cuts are meant to stand in for a more detailed description of the role of institutions in facilitating exchange. Two possible explanations for such implicit theorizing are: 1) the modelers do not care about making their assumptions explicit; and 2) they cannot figure out how to do it.

We understand that the problem may seem hard, and if one cannot figure out how to model things explicitly, one is reduced to reduced-form reasoning. It is harder to understand the position that we do not (or should not) care about modeling the process of exchange explicitly. How could one say it does not matter until one does it? Some have argued that modeling the details of exchange and intermediation is nothing more than studying the "plumbing" of the economy – it all works well behind the scenes and so we do not need to pay attention to it. This seems wrong. How do we know it is working well if we do not pay attention to it? What happens if the "plumbing" goes bad? We know what this entails, and it is not pretty. We believe

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few words on these matters in this Introduction, we refer readers to those sources for much more detail concerning why we think this approach is useful, and how it can be put to work, so that we can get on with describing the individual contributions in this collection.

<sup>2</sup>The authoritative reference for the popular New Keynesian approach where money plays no role – the model by design is *cashless* – is of course Woodford (2003). An earlier survey of New Keynesian models is contained in Clarida, Gali and Gertler (1999). Williamson and Wright (2010, in press) provide more references, including examples models that put money, bonds, or bank reserves in utility or production functions. Among those we think more of as microeconomists, including for instance Kiyotaki and Moore (2008), Gertler and Kiyotaki (2010), or Holmstrom and Triole (2010), we respect the spirit of these recent efforts to discuss liquidity and related issues, but at the end of the day their theories look a bit too much like cash-in-advance models for our taste. We would like to be able to elaborate on this, but do not have space to do justice to the issues here. Instead of critiquing alternatives, we prefer in this special issue to suggest the approach we advocate is useful and prove the point by providing examples of interesting papers.

<sup>3</sup>Certainly Debreu (1959) understood this: "[An] important and difficult question ... not answered by the approach taken here: the integration of money in the theory of value"

that it is dangerous to ignore the details of “plumbing” and that the recent financial crisis makes this obvious. We therefore think that it is important to study institutions that help to facilitate exchange, and the papers in this special issue do just that.

We have grouped the contributions together by the themes of money, credit and liquidity. Why? One of the simplest institutions is of course money, which is used as a medium of exchange to overcome the double-coincidence problem and situations where credit is difficult to use.<sup>4</sup> But work in the area has gone well beyond studying how currency ameliorates frictions in trade. The study of credit and banking arrangements is another important area where there has been recent progress.<sup>5</sup> In general, a characteristic of the methods we are advocating is a focus on liquidity. Liquidity is discussed in other branches of economics and finance, of course, but we think the approach adopted by the papers in this collection is especially fruitful. In particular, some of the most interesting work on financial markets and asset pricing is very much consistent with methods developed in the microfoundations of monetary economics literature.<sup>6</sup>

All of this work is based on the fundamental principle that exchange needs to be modeled explicitly. This involves building models with detailed descriptions of the process of trade. More importantly, it means incorporating frictions that make exchange less than perfect, so that there is an essential role for institutions that help facilitate the process. Such frictions include limited commitment, imperfect information or record keeping, and so on. This is what the literature has been up to for the last two decades. The objective of the current special issue is to illustrate by way of example some of what people are doing in frontier research along these lines. The papers in this collection take various different, but definitely related, approaches

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<sup>4</sup>Early examples of work in this literature studying the role of commodity or fiat money as a medium of exchange include Kiyotaki and Wright (1989,1991) and Ayigari and Wallace (1991). Much of the modern research in the area uses the more recent models in Shi (1997) or Lagos and Wright (2005). In between, there was much work extending the basic framework, including e.g. Shi (1995) and Trejos and Wright (1995), and clarifying exactly what frictions are required to make a medium of exchange essential, including e.g. Kocherlakota (1998*a,b*) and Wallace (2001). Again, see Nosal and Rocheteau (in press) for a summary. Much of this research is pure theory, but recently there has been much more quantitative work, including as recent examples Aruoba, Waller and Wright (2009) and Aruoba and Shorfheide (in press).

<sup>5</sup>A position advocated in Williamson (1987) is that what makes financial intermediation potentially worth studying are its special functions, such as diversification, information processing, and asset transformation. We cannot expect to generate these special activities or derive many useful implications if our approach does not build on the economic features that cause financial intermediaries to arise in the first place. This is another call for making ones assumptions explicit and generating market structure, including intermediation, endogenously. Berentsen, Camera and Waller (2007) and Williamson (2009) provide recent example that show how to put these ideas into practice in New Monetarist models. Sanches and Williamson (2010) is an example of more detailed analysis of credit and its interaction with monetary exchange. Nosal and Rocheteau (in press) provide many other applications in the study of credit and payments systems.

<sup>6</sup>We have in mind e.g., papers by Duffie, Gârleanu and Pederson (2005,2008), Lagos (2008), Lagos and Rocheteau (2009), or Lagos, Rocheteau and Weill (2010).

to the substantive issues at hand. They all try to incorporate details of the exchange process in hope of enhancing our understanding of the way it works. By way of preview, we now summary the individual contributions.

## 2 The Papers

“Coin Sizes and Payments in Commodity Money Systems” by Angela Redish and Warren Weber is an example of applying the framework to issues in monetary history (they reference other such applications). They argue that several features of medieval and early modern European commodity monetary systems are hard to capture using models of centralized exchange. For example, physical characteristics of commodity money, such as coin size, created shortages of small change, which had real effects on trade. To confront these issues, they construct a random matching model with indivisible coins with different intrinsic values. The paper shows that small change shortages can exist in the sense that welfare increases when small coins are added to a large coin economy. Further, they study the real implications of changes in the denomination structure and in the quantity of metals in commodity money. They show that replacing full-bodied small coins with tokens may not improve welfare. It would be difficult to examine these sorts of issues and generate the interesting economic results that they obtain using reduced-form models with, say, cash-in-advance constraints.<sup>7</sup>

In “Banking, Liquidity and Inflation,” Jonathan Chiu and Cesaire Meh develop a search-based model to study the interaction between banking and monetary policy, extending earlier work by Berentsen, Camera and Waller (2007). They argue that understanding the nature of intermediation is critical for assessing the cost of inflation. They find that, when banking is explicitly in the model, inflation generates smaller welfare costs, compared to a no-banking environment, due to avoiding costs associated with intermediation. In equilibrium, monetary policy affects the affects welfare in rather interesting ways. When inflation is low, banking is not active, and when it is high, banking is active and improves welfare by channeling liquidity to those who need it most. At moderate levels of inflation, welfare is actually reduced by banking activity. But, owing to general equilibrium feedback, banking can be active in equilibrium at moderate inflation levels, even though welfare is higher without it. This is a nice example of how being careful with the details of the exchange process makes a big difference for understanding intermediation.

In “On the Threat of Counterfeiting,” Yiting Li and Guillaume Rocheteau study counterfeiting issues. In contrast to earlier work by Nosal and Wallace (2007), Li and Rocheteau show that a monetary equilibrium always exists, irrespective of the

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<sup>7</sup>There have been attempts, including the interesting work of Sargent and Velde (2002), but we think the cash-in-advance approach is simply not as natural or as rich. See Wallace (2003) for a more detailed critique of Sargent and Velde’s approach

technology for producing and the technology for identifying counterfeits. Nevertheless, the possibility of counterfeiting fiat money affects its value, as well as velocity, output and welfare, even if no counterfeiting occurs in equilibrium in their benchmark model. Policies that make currency more costly to counterfeit, or easier to recognize, will raise the value of money and welfare, but may not always decrease counterfeiting. We think this is a nice contribution to recent research that studies the role of recognizability in determining which objects are used in payments and at what prices. Private information about asset quality is important and interesting in theory and in practice, and this kind of analysis helps us understand how to analyze models where this is made explicit.

In a related paper, “Money, Markets and Dynamic Credit,” Amy Sun provides a theory of money and credit. Financial intermediation is studied when both the intermediary and individuals have private information. Money is essential because it helps solve a dynamic two-sided incentive problem. Requiring settlement with fiat money induces market trades that generate information-revealing prices that better discipline the intermediary. If financial intermediaries can issue private money – money that records its own history of being used in settlements – then it is optimal to have only private money circulate in the economy. This kind of analysis greatly enhances our understanding of intermediation, payments and settlement.

“Liquidity Provision in Capacity Constrained Markets,” by Pierre-Oliver Weill, follows up on some of his previous work, Weill (2008). He analyzes a dynamic financial market, where market makers face a capacity constraint on trading with outside investors, and the financial market is subject to a transient selling pressure. Market makers manage their capacity constraint over time and, as a result, liquidity to the market. When selling pressure is strong, they use slack capacity early to accumulate assets, so as to relax their capacity constraint and sell to buyers more quickly when the selling pressure subsides. When the capacity constraint binds, the bid-ask spread is strictly positive and depends on the change in inventories. A key insight is that variations in bid-ask spread are not a symptom of inefficient liquidity provision, since the equilibrium asset allocation is constrained Pareto optimal. This is another interesting contribution to the study of finance that incorporates explicit frictions into the theory.

“Monetary Policy Implementation Frameworks: A Comparative Analysis” by Antoine Martin and Cyril Monnet presents two stylized frameworks for the implementation of monetary policy that resemble what we actually observe in practice. The first framework has only standing facilities, while the second implements monetary policy through open market operations. Although the Friedman rule cannot be implemented when the central bank uses standing facilities only, for a given rate of inflation that can be achieved by both frameworks, standing facilities unambiguously deliver higher welfare than open market operations. Their results suggest that any monetary policy implementation framework should remunerate both required and excess reserves. This is an example of recent work in this literature that tries to model the details of

policy implementation explicitly.<sup>8</sup>

The next two papers revisit an old idea in monetary economics, the ‘Hot Potato’ effect of inflation (people spend their money faster when inflation goes up). While this intuition has been around for a long time, formally modeling it is more challenging than one thinks. In the paper by Lucy Liu, Liang Wang and Randall Wright, it is argued that monetary theory with endogenous search intensity seems ideal for studying this issue, but in standard models, since inflation is a tax that lowers the surplus from monetary exchange, it actually reduces search effort and therefore the speed at which people spend their money. The authors therefore replace search intensity with a free entry (participation) decision for buyers, and focus on the extensive rather than intensive margin. They show that in this model buyers always spend their money faster when inflation increases. In his related paper, Ed Nosal focuses on intensive margin effects to show that an increase in inflation causes people to speed up their spending. In the model, buyers must exit the market after making a trade and have to wait in a queue to re-enter the market. When waiting is costly, buyers are very choosy in terms of their purchases – even though a match can generate surplus, a buyer may forego the trade if the surplus is small. An increase in inflation makes buyers less choosy.

These two papers are interesting from the point of view of this collection for the following reason. Many times those of us who work on microfoundations hear the following question: What can one do with a search model that one could not do with a reduced-form model that assumes money enters the utility function or imposes cash in advance constraints? This is a subtle issue. We have learned over the years that the key frictions making a medium of exchange essential are more about limited commitment and information than about spatial or temporal separation per se, even though search theory provides us with natural environments within which we can easily incorporate the relevant commitment and information frictions. For many questions, search may be useful but it is not strictly necessary. For the questions in these papers – does inflation make people spend their money faster, and what are the implications for the effects of monetary policy on velocity, output and welfare? – search is of the essence. By definition, search theory is the way to endogenize the time it takes to trade.<sup>9</sup>

The papers on the ‘Hot Potato’ effect show that how one models the search process can make a big difference for the predictions of theory. It is also known that it matters how one models the determination of the terms of trade in both theoretical and quantitative applications. In “Inflation and Unemployment in Competitive Search Equilibrium,” Mei Dong provides another illustration of this important message. In earlier work, Rocheteau, Rupert, and Wright (2007) show that the relationship between inflation and unemployment (i.e. the long run Phillips curve) can be positive or

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<sup>8</sup>See also Berentsen and Monnet (2008) and Berentsen and Waller (in press).

<sup>9</sup>Earlier work using search theory to study the impact of inflation on the time it takes to spend ones money, velocity, and welfare includes Li (1995), Lagos and Rocheteau (2005), and Ennis (2008).



negative, depending on preferences, in models where both unemployment and monetary exchange are modeled with explicit microfoundations. However, they assumed random search and used bargaining for price determination, and were only able to prove their results under the extreme assumption of buyers making take-it-or-leave-it offers. Dong instead uses directed search and price posting, and is able to prove the same results, plus interesting extensions, more generally. Again, it is clear from all of this work how details of the process by which agents meet and the mechanism by which they choose the terms of trade make a big difference for monetary theory and policy. We see nothing like this message having emerged from the cash-in-advance or money-in-utility-function literature. We see less in the New Keynesian literature.

Moving right along, a paper that emphasizes both the process by which agents meet and the nature of private information is “Adverse Selection, Segmented Markets and the Role of Monetary Policy” by Steve Williamson and Daniel Sanchez. In their model, trading partners are asymmetrically informed about future trading opportunities, and spatial and informational frictions limit arbitrage between markets. These frictions create inefficiencies, the extent of which is affected by monetary policy. A Friedman rule is optimal under a wide range of circumstances, including ones where segmented markets limit the extent of monetary policy intervention. These kinds of models teach us much about the way exchange works in decentralized environments and this can have important policy implications.

In “Random Matching and Money in the Neoclassical Growth Model: Some Analytical Results,” Christopher Waller adds long-run technical change to the monetary version of the neoclassical growth model used by Aruoba, Waller and Wright (2009) to study the impact of inflation on capital accumulation. In the prevailing literature, using a reduced-form approach, the exchange process is not modeled and so we cannot be sure the effects of inflation on anything, including growth, are being captured appropriately. Waller tries to shed light on this issue by incorporating matching frictions and bargaining into neoclassical growth theory. A key result is that inflation lowers per capita income in steady state, as well as the growth rate of the economy along the transition path. Although the Friedman rule is optimal, it does not give the first best outcome under bargaining due to a holdup problem. This paper is another step in the research program trying to reduce the gap between mainstream macro and models that take seriously the microfoundations of exchange.

The final paper, “The Welfare Cost of Inflation in OECD Countries” by Paola Boel and Gabriele Camera, is more quantitative in nature. It is known that the cost of anticipated inflation in search-and-bargaining models when calibrated to the US economy can be an order of magnitude higher than in traditional reduced-form models.<sup>10</sup> Boel and Camera measure the cost of inflation in a microfounded model of money calibrated to each of twenty-three OECD countries for several sample periods.

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<sup>10</sup>Thus, in Lucas (2000) or Cooley and Hansen (1989) one finds that eliminating a 10% inflation is worth roughly 1/2 of 1% of consumption, while in Lagos and Wright (2005) the same policy can be worth 10 times as much.

With pricing taking, they predict that agents in most of the countries would give up less than 1% of consumption to eliminate 10% inflation. When one assumes bargaining, however, agents are willing to give up as much as 6% to eliminate 10% inflation in some countries. The results presented here further our knowledge of the quantitative properties of the models in monetary theory. This, of course, an important ongoing part of the ongoing research agenda.

In summary, first, we think that tremendous progress has been made over the last two decades on New Monetarist models. Also, we believe that the papers in this special issue, individually and collectively, advance our understanding of how money, credit and liquidity affect the exchange process and this is relevant both in terms of theory and policy analysis. But while our understanding of the roles of money, credit, intermediation and related institutions has improved greatly, there is much more to be done. The recent financial crisis makes this apparent. We believe the papers in this volume constitute another step in building the foundations for future research.

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