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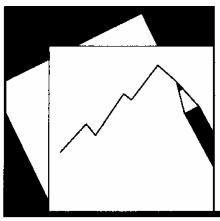

IMF Working Paper

Six Puzzles in Electronic Money and Banking

Connel Fullenkamp and Saleh M. Nsouli

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Six Puzzles in Electronic Money and Banking

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Abstract

The literature on the economic effects of electronic money and banking lacks organization and a common analytical framework. This paper identifies the main issues raised by e-money and e-banking and presents them as six puzzles. Our solutions to the puzzles build a framework for analyzing the effects of e-money and e-banking, and for choosing the appropriate approach to regulating electronic money and banking. Although electronic money and banking will likely not fulfill the more dire predictions in the literature, such as the possible loss of central banks' ability to control the money supply, they nonetheless will need to be regulated carefully.

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I. INTRODUCTION

In the past several years, many economists have considered the impact of the digital revolution on the money and banking system, and by extension the macroeconomy. Although many of the papers on e-money and e-banking have contained useful insights into these developments, they have also tended to paint an incomplete and even confusing picture. The application of information technology to money and banking raises many interesting questions. But to make further progress in understanding the economic effects, we need to advance in two areas. First, we need to settle on a fundamental set of questions that a theory of electronic money and banking should answer. Second, we must build frameworks that can address the basic questions raised by electronic money and banking.

In this paper, we present a set of questions or puzzles whose answers will give a complete picture of electronic money and its impact on the economy. We focus on six basic puzzles, which we explain below. The puzzles tend to build on each other, so that a satisfactory answer to the fourth puzzle will require satisfactory answers to the previous three, and so on.

Next, we will develop a model of e-money and e-banking to answer the questions raised. The model will be constructed as we present our answers to the six puzzles. Our goal is to keep the model as simple as possible. We find that a simple IS-LM framework can demonstrate the main effects of electronic money and banking. We also develop a somewhat more complex model of the money market under e-money, which corroborates our views regarding the effects of the introduction of e-money.

The paper proceeds as follows. In Section II, we describe the six puzzles. In Section III, we discuss how the literature on electronic money and banking gave rise to the six puzzles. In Section IV we present our solutions to the six puzzles and construct the models of e-banking and e-money to analyze their macroeconomic effects. Section V gives our conclusions.

II. SIX PUZZLES IN E-MONEY AND E-BANKING

A. Do We Know What We Are Talking About?

The first puzzle of electronic money and banking is the terminology. The most popular terms used in the literature are electronic money, electronic cash, and electronic banking. What do these terms mean exactly? How do they differ? There is a tendency in the literature to assume that the reader knows what the author means by, say, e-money, or to define terms by example rather than by precise description. On the other hand, some authors wish to avoid the impression that their analysis is tied to one specific type of e-money, so they use the term electronic payment media or a similar general term. This leaves the reader wondering what the author has in mind—e-money, e-cash, e-banking, some of the above, or even none of the above?

In addition, it is possible that the terms in popular use may not have very precise meanings. When we say we are interested in electronic money, for example, are we really interested in all

electronic money? The economic effects we have in mind may only be associated with a certain type of electronic money, or some attribute of electronic money.

B. What Is Really Different About Electronic Money and Banking?

The discussion of electronic money and banking has tended to be driven by the "Gee Whiz" effect: an infatuation with the latest electronic gadgets. Home banking over the Internet and smart cards have been special favorites of authors, for example. While these are certainly interesting tools, and their use may indeed have economic consequences, the focus on the gadgets has obscured a more important question: what are the truly innovative features of electronic money and banking? What is different about these new products and services that may lead to macroeconomic effects? Having a set of precise terms to describe electronic money and banking instruments and services is essential to answering these questions.

C. Will Changing Bricks into Clicks Affect the Economy?

After several experiments with Internet-only banks, the banking industry has settled on a mixed model of physical branches combined with Internet banking—hence, bricks and clicks. There is a question about what effect, if any, does the increased use of electronic banking have on an economy. In particular, does increased e-banking affect the central bank's ability to control the money supply or to adjust the short-run levels of output and employment? This depends on what electronic banking is, and what is innovative about it.

D. Gresham's Law Puzzle

Gresham's Law states that bad money drives out good—cheap money drives out expensive money, where the definitions of cheap and expensive depend on several factors, including the prices of different monies in terms of goods and the cost of using each type of money. Will electronic money drive out other forms of money, such as currency? In order to answer this question, we need to get into the details about how an e-money provider will function, and how e-money will be used. We also need to ask, Under what conditions will electronic money, and its providers, survive and flourish? The answers depend on how the electronic money is defined, what its innovative properties are, and the role that the main providers of existing money—the banks—are playing in the model.

E. Monetary Policy Without Reserves? Without Money? Without a Clue?

The impact of electronic money and banking on the monetary transmission mechanism has been one of the focal points of the recent literature on electronic money and banking. Some authors have argued that central banks will have to substantially modify their operating procedures in order for monetary policy to have efficacy, while others have argued that monetary policy will lose its relevance to economic activity. But one's view of the future of monetary policy in an e-money world depends critically on the particular model of the money and banking system one has in mind. This, of course, depends on the operational details of the system (Puzzle 4), including what the banking system does (Puzzle 3), the innovations of e-money and e-banking that are modeled (Puzzle 2), and indeed exactly what is meant by e-money in the model (Puzzle 1).

F. Do We Need a Protective Firewall? Can We Build One?

The final puzzle is what regulators should do about electronic money and banking, if anything. This involves identifying the threats to the economy and society from electronic money and banking, if any, and then thinking carefully about the policy options that regulators have. It is certainly possible that, even if electronic money and banking does possess a threat to society in some way, regulators may be powerless to prevent or even manage this threat. Again, the conclusions are going to depend on the model of the electronic money and banking system that is developed, including the monetary transmission mechanism.

III. THE SOURCES OF THE SIX PUZZLES

The six puzzles are inspired by the growing literature on e-money and e-banking. Policy puzzles 4 to 6 are taken more or less directly from the literature, as we show below. But the first three puzzles arise because the literature is at times too specific and narrowly focused on a particular type of electronic money and banking, and at other times is too broad or vague about what electronic money and banking actually entails.

The vast majority of the recent literature on electronic money and banking suffers from a narrow focus, arising from the Gee-Whiz effect mentioned above. It generally ignores e-banking entirely and equates e-money with the substitution of currency through electronic gadgets such as smart cards and virtual currency.[2] For example, Freedman (2000, p. 218) proposes that e-banking and e-money consist of three devices: access devices, stored value cards, and network money. E-banking is simply the use of new access devices and is therefore ignored. E-money, then, is the sum of stored value (smart) cards and network money (value stored on computer hard drives). What is most fascinating, and revealing, about this apparently popular view is that e-banking and e-money are no longer functions or processes, but devices.

Within this rather narrow scope for e-money, there are nonetheless many papers that address one or more of the three policy puzzles mentioned above. The first of the policy puzzles is Gresham's Law Puzzle, number 4 described above. Santomero and Seater (1996), Prinz (1999), and Shy and Tarkka (2002), and many others present models that identify conditions under which alternative electronic payments substitute for currency. Most of these models indicate that there is at least the possibility for electronic substitutes for currency to emerge and flourish on a large scale, depending on the characteristics of the various technologies as well as the characteristics of the potential users.

Other papers address the impact of these currency substitutes on monetary policy, which is included in Puzzle 5. Berentsen (1998) considers the impact that the substitution of smart cards for currency will have on monetary policy, arguing that although electronic substitutes for currency will become widespread, monetary policy will continue to work as before because this currency substitution will leave the demand for central bank reserves largely intact. Goodhart

[2] Bernkopf (1996) is a rare exception.

(2000) discusses how monetary control would work in an economy in which central bank currency has been partially or completely replaced by electronic substitutes. Cohen (2001) distinguishes between monetary control and monetary autonomy, where monetary control is the ability of the central bank to control monetary aggregates, and monetary autonomy is the ability of the central bank to influence output and prices. Cohen argues that the introduction of electronic currency substitutes will not reduce monetary control, but may reduce monetary autonomy. At one extreme, Kobrin (1997) argues that electronic currency substitutes are part of a general process of technological advance and globalization that are rendering national authorities of all kinds impotent and obsolete.

A final group of papers addresses Puzzle 6, the regulation puzzle, again in the context of electronic currency substitutes. Lee and Longe-Akindemowo (1999), for example, present the standard justifications for regulation of financial markets—systemic risk and consumer protection—and argue that both will justify regulation of electronic currency substitutes. They note that European regulators have already defined stored value cards as the taking of a deposit, so that only banks may issue them. Several other authors, particularly central bankers such as Freedman (2000), have argued that the state can always use its power to regulate electronic money providers if they prove to be detrimental to monetary policy or financial stability. Helleiner (1998) makes the case that such coercive power will still be effective in a world of electronic currency substitutes. Tanaka (1996), on the other hand, proposes the establishment of a monetary authority in cyberspace that will control electronic currency substitutes.

These papers give a fairly complete view of the possibilities of electronic currency substitutes. But they also beg the question of whether we should be worried about this aspect of e-money, or a different one. In other words, they attack the interesting policy Puzzles 4–6 mentioned above, but they give rise to the first three, more basic puzzles.

A smaller set of papers takes a broader view of electronic money while addressing Puzzles 5 and 6. This line of literature comes from Friedman (1999), a provocative essay on the future of monetary policy whose main points are reinforced in Friedman (2000). Friedman points out that electronic money presents the possibility that an entire alternative payment system, not under the control of the central bank, may arise. In an extreme variant of Friedman, King (1999) argues that today's computers make it at least possible to bypass the payment system altogether, instead using direct bilateral clearing and settlement. The responses to Friedman, such as Freedman (2000) and Woodford (2000), argue that the central bank will either continue to provide the payment system of choice, or will find alternative ways to conduct monetary policy through stabilization of short-term interest rates regardless of what form of money is being used.

Although this second set of papers introduces some critical issues that we pursue below, it is too vague about what exactly is meant by electronic money and banking. Part of this vagueness stems from the focus of these papers on the payment system rather than on the payment media. Nonetheless, a complete view of electronic money and banking should include both the payment system and the media used in the system. The feasibility of an alternative payment system, after all, is intimately tied to the feasibility and desirability of the media flowing through that system.

IV. Solving the Puzzles and Building a Model of Electronic Money and Banking

In this section, we discuss our answers to the six puzzles in electronic money and banking, and construct our model of electronic money and banking as we go.

A. Puzzle 1 Solution: Finding Better Definitions

Our solution to the first puzzle is to offer the following basic definitions, which we will supplement as necessary. We begin with e-banking.

Electronic banking, or e-banking, is the use of electronic methods to deliver traditional banking services using any kind of payment media.

By "traditional banking services" we mean taking deposits, making loans, and clearing payments. The effect of e-banking is to augment or facilitate existing banking and payment mechanisms, primarily by making many transactions cheaper, faster, more secure, and more convenient. In short, e-banking refers to how banking and payment transactions are conducted.

This definition implies that e-banking has been taking place in various forms for decades. Telephone banking, for example, which enables account holders to conduct several kinds of transactions, has been used since the advent of touch-tone dialing. Similarly, automatic teller machines (commonly called ATMs or bankomats) are a form of retail e-banking in use since the mid-1970s and in nearly universal use since the late 1980s. E-banking, in the form of MICR technology for payment clearing and settling, has been in use even longer than the retail e-banking technologies.

Now we define e-money.

Electronic money, or e-money, is any electronic payment media—any material, device, or system that conducts payment via the transfer of electromagnetically stored information.

E-money may be "currency" in that it can be stored in a physical "wallet" like a smart card or token, but it generally exists as account data on some electronic storage device. Credit cards fit under this definition of e-money. Banks already create e-money as part of their normal lending process, when they issue loans by crediting the deposit accounts of the borrowers (or the receiver of the loan proceeds). In fact, paper cheques have become e-money, thanks to truncation.

Electronic currency or electronic cash is an inaccurate name and possibly a contradiction in terms. The term usually refers not to the money itself, but to a portable storage device for e-money that can be carried like cash and used in place of cash. An example is the stored value card. The storage device does not circulate, since the holder of the card retains the device after the transaction. A better term is electronic purse. Electronic purses, moreover, are not necessary for an electronic currency replacement. Physical electronic purses, which can be lost, stolen, or damaged, can be replaced by electronic money systems that use biometric identification, such as thumbprints or retina images, to enable individuals to access their e-money balances remotely.

The above definitions of e-banking and e-money remind us that these concepts are not really new. Why, then, the sudden interest in them during the past few years? The answer is found by thinking about the second puzzle: what's really different about e-banking and e-money?

B. Puzzle 2 Solution: Internet Innovation in E-Banking and E-Money

In the case of electronic banking, the innovation is the increased speed and convenience, and decreased cost, of monitoring one's banking assets and making transactions with them. The sudden interest in e-banking has come about because the application of the Internet to e-banking represents an order-of-magnitude increase in the speed and convenience of making banking transactions, including bill payment. This is an evolutionary innovation of considerable magnitude. For example, before the arrival of Internet banking, most people had to drive to their bank branch or to an ATM to make simple transfers between accounts. Although telephone banking was possible, the procedure, such as keying in a long string of account numbers, proved too cumbersome to ever become the preferred method of e-banking. This suggests that the appropriate term to use when thinking about the effects of the most recent innovation in e-banking is Internet e-banking.

Turning to the innovation in electronic money, we first consider the electronic purse. While devices such as stored value cards will certainly be a great convenience for their users, their true innovation is in offering a new way to temporarily store and transport purchasing power. Electronic purses may be more convenient to carry on one's person, they may be more secure (but may not be, depending on the exact form of the purse), and they generally solve the "exact change" problem. They will probably affect the demand for currency, and they may have a noticeable effect on the overall demand for money because of the increased convenience. But in itself this does not seem to be a dramatic innovation, which is not terribly surprising once we redefined the sexy term "e-cash" properly as the far more mundane "e-purse."

Given that e-money already exists to fill the electronic purses, what is innovative about it? As in the case of e-banking, the arrival of the Internet has brought about a new possibility for an existing technology. In particular, the Internet makes possible the reemergence of private money, in electronic form. A further definition is thus in order.

Private e-money is electronic money that originates from a private, nonbank firm.

In order to be truly private, e-money must originate outside the government and outside the banking system, because money creation inside the banking system is regulated by the central bank and other government agencies. For clarity and convenience, we refer to e-money that originates in the banking system as government money, since it is under the regulation of the central bank. Government money is the sum of government e-money and fiat currency.

All of the new e-money that has been created on the Internet to date is actually government e-money. As an illustration, consider the services provided by PayPal (www.paypal.com). This service enables the user to send a payment to anyone with a PayPal account or an email address. The payments are made in U.S. dollars or in one of the other currencies that PayPal chooses to deal in. While PayPal makes payments using e-money, the e-money is not private. PayPal works through the banking system, because any payment that moves through PayPal must enter and

exit PayPal's system either though an electronic bank transfer or through a credit card payment, which is also an electronic bank transfer. Thus, PayPal is conducting e-banking (payment) services using government e-money, not private e-money. PayPal is certainly a useful convenience to millions of users, but its innovation is in extending the existing credit-card system to a new set of users.

The distinction of interest is between government e-money and private e-money. Truly private e-money must be distinct from, and a substitute for, government money. When the existing literature refers to e-money, it is generally referring to private e-money, not government e-money. Central banks have already demonstrated that they can maintain monetary control and achieve their policy goals in a world with government e-money. Indeed, most monetary policy is conducted through open-market operations, which use e-money.[3] Whether central banks can continue to achieve their policy goals in a world with private e-money is the unanswered question and the basis of Puzzle 5, which we discuss later.

C. Puzzle 3 Solution: Drag and Drop the LM Curve with Internet E-Banking

Now we consider the impact of the innovation in Internet e-banking. The main innovation in electronic banking is a dramatic reduction in the cost of banking transactions. We use the Baumol-Tobin framework to discuss money demand. With the Baumol-Tobin framework, money is held for transaction purposes but has a cost in terms of forgone interest on other assets. Users of money would like to economize on money holdings by making frequent transactions to sell interest-bearing nonmoney assets, but these transactions are costly. The costlier the transactions, the fewer times they are made and the more money will be demanded at any time. The reduction in the average cost of transactions, due to the adoption of Internet e-banking, will enable users of money to further economize on holding cash balances.

A further consequence of the reduction in transaction costs is that users of Internet e-banking will have greater access to interest-bearing assets, including ones offered by mutual fund companies and brokers. Before Internet banking, it was costly for a household to shift funds out of a bond fund or an equity position and into a transaction account at a bank. This effectively limited the opportunity cost of holding money, since these assets were not realistically available for storing idle cash balances. The reduction in transaction costs has increased the range of assets available and therefore increased the opportunity cost of holding money. We should therefore expect to see a greater interest sensitivity of money demand as Internet-based e-banking becomes widespread.

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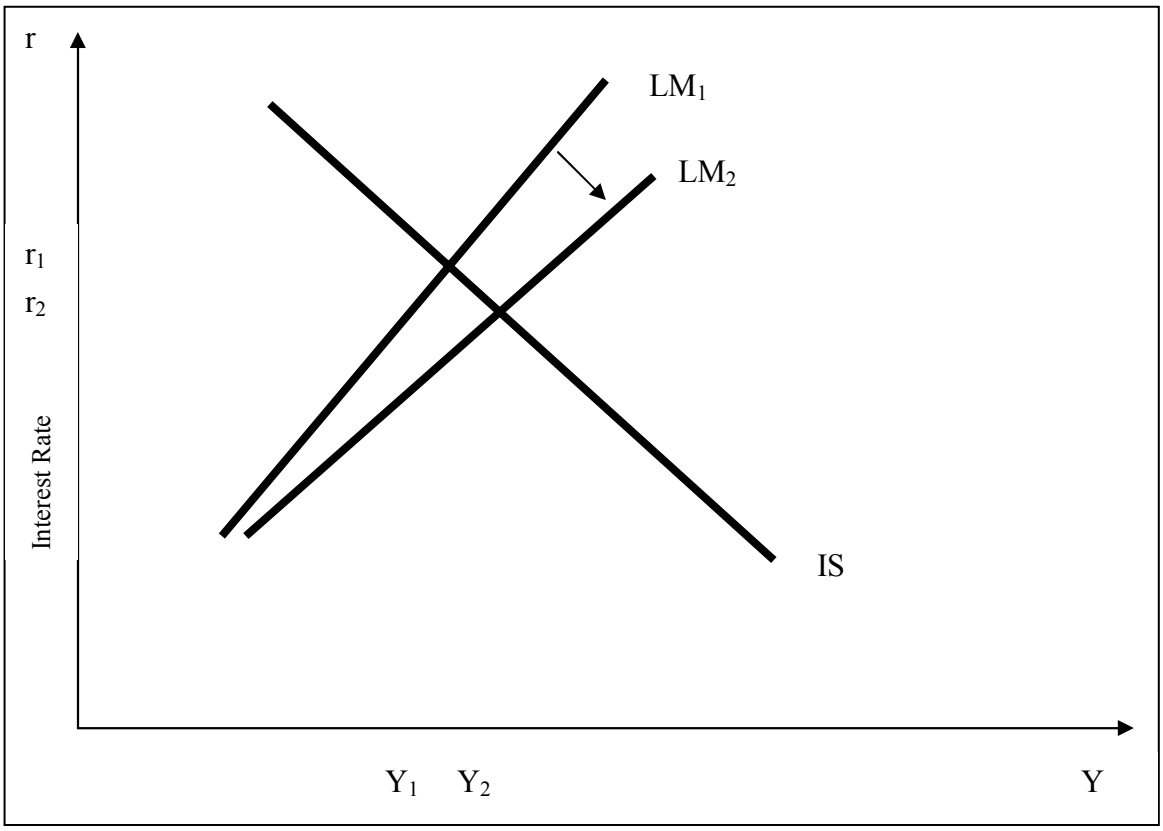
[3] Central banks use e-money at the wholesale level to conduct open-market operations. They could also become "retail" e-money providers and conduct monetary policy through electronic lotteries, which would be equivalent to the textbook example of currency dropped from helicopters. It is unclear why the central bank would wish to infringe on the private banks' franchise for providing retail e-money, however.

The two effects of Internet e-banking, therefore, are a permanent decrease in money demand and an increased interest elasticity of money demand.[4] That is, average cash balances held decline because of the reduction in transactions costs (the "shoe leather" costs in the classic Baumol-Tobin model), while the interest elasticity increases because of the effective increase in the opportunity cost of holding money. The macroeconomic effects of these changes are easily shown using a simple IS-LM model and are illustrated in Figure 1. An autonomous decrease in money demand will shift the LM curve downward. For each level of income, less money will be demanded and the equilibrium interest rate will be lower. An increase in the interest elasticity of money demand, on the other hand, will make the slope of the LM curve flatter (infinitely elastic money demand leads to a horizontal LM curve). Thus, in Figure 1, the LM curve shifts down from LM_1 to LM_2, where LM_2 is flatter than LM_1.

The downward shift in the LM curve leads to higher output and a lower interest rate. The obvious question regards the magnitudes of the flattening and shifting of the LM curve. The adoption of Internet e-banking has been taking place gradually since the mid-1990s, so that the LM curve has already been shifting and flattening in this manner. Andersen (1997) reported that at the end of 1996, between 1.5 and 2 million U.S. households were using Internet banking. Hoffman (2002) reports that in 2002, 15 percent of all bank customers banked online, though no statistics are available regarding whether Internet banking users performed all or most of their banking transactions over the Internet. In addition, according to the American Bankers Association (2001), the most frequently performed tasks conducted through Internet banking were obtaining information on interest rates and products offered by the bank rather than performing actual banking transactions. Nevertheless, surveys indicate that over two-thirds of households are interested in using the Internet for account transfers, and Internet bill paying services are becoming more popular as well. This evidence suggests that the LM curve will continue to shift over time, and that the majority of its impact has yet to be felt. In addition, the magnitude of the decrease in money demand due to the adoption of Internet banking is unknown and likely to be small rather than large over the course of a single year. Nonetheless, the cumulative effect of this change, which the diagram demonstrates, may be quite large. In addition, the diagram shows further reasons why the U.S. economy experienced declining interest rates and sustained economic growth during the late 1990s. The Internet boom of the late 1990s was not completely an Internet bubble—Internet banking also played a role.

[4] There is also the possibility that Internet e-banking, like any other labor-saving technology, will result in a positive productivity shock. We focus on the money demand effects because they seem more direct and likely to have an appreciable macroeconomic impact.

Figure 1
Effect of Introduction of E-Banking



An interesting and somewhat ironic consequence of Internet e-banking is that the flattening of the LM curve implies that monetary policy will be less effective in adjusting short-run output, relative to the period before Internet e-banking. A flat LM curve, of course, represents Keynes's liquidity trap, in which the use of monetary policy is likened to "pushing on a string." This implies that fiscal policy will be relatively more effective than it was before e-banking.[5] Again, the extent of the flattening of the LM curve is unknown and will continue over a number of years, until e-banking reaches its maximum usage rate.

Clearly, monetary control and autonomy will still be possible in the presence of Internet e-banking. The ability of the central bank to adjust the short-run level of output is changed in terms of the details, but is definitely not eliminated. A simple way to think about this is to envision the money multiplier. The introduction of Internet e-banking changes the parameters in

[5] See, for example, Mankiw (1997).

the money multiplier, but it does not disrupt the money multiplier process. The central bank, however, will have to periodically reestimate these parameters and adjust the magnitude of its interventions accordingly. Similarly, the introduction of Internet e-banking will change the values of the parameters governing the monetary transmission mechanism, but it will not disrupt or eliminate the central bank's basic ability to affect output.

The upshot of the introduction of Internet e-banking is the following. As the usage rate of Internet e-banking increases, there will be downward pressure on interest rates and upward pressure on GDP as formerly idle transaction balances are reallocated to savings, which will fund more investment projects. At the same time, however, monetary policy will become less potent at the margin—a given monetary injection by the central bank will increase short-run GDP by a smaller amount than before. The exact magnitudes of these changes are unknown and will have to be estimated by the central bankers periodically, but they do not fundamentally change the nature of the monetary transmission mechanism. Increased regulation of e-banking will not arrest the flattening of the LM curve, unless it raises transaction costs—which reduce efficiency and can lead to distortions in the pricing of banking services.

D. Puzzle 4 Solution: The Nuts and Bolts of Using and Providing Private E-Money

Because the innovation behind Internet e-banking was relatively simple and easy to integrate into existing macro models, we were able to derive the macro consequences from e-banking in a single step. Determining the consequences of the innovation in e-money, on the other hand, requires a two-step process. First, we need to set up a model of a private e-money system. Then we need to integrate the model of private e-money into the model of the money market and by extension the macroeconomy. The first step will provide the answer to the fourth puzzle, while the second step will provide the answer to the fifth.

As the name of the puzzle suggests, Gresham's Law gives us one way to think about the likely characteristics of private e-money: it won't be demanded at all if it is very costly to use. But money has three functions, and all three must be considered. For example, the store of value function of money implies a portfolio-theoretic approach to money. Money is an asset, and private e-money can have a return that differs from the returns on currency and on government e-money. This return can offset some of the costs of using private e-money, making it attractive even if it is more costly to use, and riskier, than government e-money. A good way to construct a model of private e-money is to think about how it would fulfill the three functions of money: unit of account, medium of exchange, and store of value.

We begin with the unit of account function of money. Since government money already exists, the providers of private e-money have a simple choice: adopt the same denomination as government money, or introduce a different denomination. Adopting a different denomination from government money seems to have little or no benefit under normal circumstances. Under conditions of high or hyperinflation, however, a private e-money may signal a commitment to stable value by choosing a denomination that differs from that used by government money. This is an interesting possibility that we leave for future research. But outside of this case, adopting a new denomination would only impose an unnecessary cost on those who transact in the private e-money, since they would have to constantly convert the value of their private e-money holdings to their value in government money in order to compare their value to everything else.

Even if this is simply an annoyance, it is sufficient to rule out the use of private e-money under normal circumstances. Therefore, we propose that private e-money will adopt the same denomination as government money in order to avoid unit-of-account costs—that is, it will exchange at par with government money.

Given our conclusion regarding the denomination of private e-money, the medium of exchange function of money focuses attention on transaction costs. Both government and private e-money incur transaction costs. The costs are basically those associated with clearing and settlement, though some additional security and storage costs related to currency are also involved. We ignore currency, since the demand for it is accommodated by the central bank, and because it is extremely unlikely that private physical currency will appear on a large scale owing to existing laws. Shy and Tarkka (2002) present a very nice framework for thinking about transaction costs and their effect on the payment media used. In particular, the authors' concept of a "transactions space" is a good way to think about how transaction costs may affect the use of private e-money. Basically, a transaction space exists for a particular medium of exchange if it is the cheapest medium to use for both the payer and the payee. In terms of transaction costs, it is difficult to say whether private e-money or government e-money will be cheaper for payers or payees. An entirely possible, if not likely, outcome is that the marginal transaction costs for clearing and settling electronic payments will be about the same for both government and private e-monies. Therefore, private e-money could occupy the same transaction space as government e-money. Settling paper transactions, of course, will remain far more expensive.

Although private e-money is probably similar to government e-money in terms of its average transaction costs, it must still overcome an initial cost in terms of wary consumers. A reasonable presumption would be that private e-money will not displace government e-money (for transactions purposes) without a compelling reason. There may exist, however, a niche for private e-money in facilitating transactions that are currently impossible or extremely costly to conduct using government money. For example, direct person-to-person payments over long distances are extremely costly using wire services such as Western Union or bank wire transfer. An Internet service such as PayPal is less costly in terms of fees, but the payments can only be passed along to somebody else in the PayPal system at a correspondingly low cost. There is a substantial delay (currently four business days) if one wants to transfer a PayPal payment out of the system and into a bank. A private e-money provider who enables a user to remit payments quickly and cheaply to any third party, and who can guarantee acceptance by the third party, should be able to find willing users for its money. This offers a possible route through which private e-money can find at least initial acceptance for transactions, and from there further "invade" the transaction space occupied by government e-money. Further reason to hold the money can then be found in the way that private e-money fulfills the remaining function of money.

The store of value function of money is an important though often overlooked factor determining the use of e-money. There is nothing preventing money from having a positive return, and indeed much of the money held by households is in interest-bearing checking deposits such as NOW accounts. Therefore, it is reasonable to assume that private e-money will also pay some positive return. As an asset, money has a return that is randomly distributed. The characteristics of this return distribution will determine the share of the household portfolio that is allocated to the

particular asset. Rather than specifying arbitrary return distributions for private e-money and government e-money, it is sufficient for our purposes to note the following ideas. First, the expected return on e-money can include compensation for transaction costs. Second, to the extent that the return on private e-money and the return on government e-money are less than perfectly positively correlated, there will be gains to diversifying one's portfolio between private e-money and government e-money. Finally, the main risks in private e-money are the absence of deposit insurance and the absence of a lender of last resort, which would both tend to increase the riskiness of the distribution.

The picture of private e-money that emerges from considering the three functions of money is a private e-money that takes the form of an interest-bearing checking account. The promised return on the balances held in the private e-money account will be higher than the return on a government e-money account, primarily to compensate for the increased risk of failure of the private provider, relative to a government-regulated provider of e-money. The return on private e-money may also compensate for any increased transaction or unit of account costs relative to government e-money, but these costs are likely to be small. A private e-money system, however, may initially gain users by performing certain transactions that are currently expensive if conducted using government money.

Now that we have established the conditions under which people would actually use private e-money, we need to seriously consider whether any private institution would want to provide it under these conditions. That is, can a private e-money provider offer interest-bearing checking accounts and still turn a profit? A private e-money provider actually combines three different revenue-generating institutions in a single firm: central bank, clearing and settlement system, and portfolio manager. Each function provides a source of revenue. The central bank function provides direct seigniorage, in which the money provider purchases goods and services by crediting the accounts of individuals and businesses, creating money in the process. The clearing and settlement system provides fee revenue from clearing and settling the transactions made in the private e-money. The final source of revenue comes from managing a portfolio of assets purchased with the private e-money deposits.

Of the three sources of revenue, direct seigniorage is likely to be quite small. There is simply a limit to the amount of in-kind revenues that an e-money provider needs. The revenues from clearing and settling fees could be significant, but the provider may have little flexibility in setting them. If the transaction fees are too high, relative to government e-money, the private provider will have to pay higher interest on deposits or face a rapid decline in demand for private e-money. The major source of revenue, it would appear, would be the same for a private e-money provider as for a bank: the returns from the asset portfolio.

The private e-money provider must be careful in its choice of assets, however. If it lends directly to its customers, then it is in the position of taking deposits and making loans—that is, it is a bank and therefore subject to all the government banking regulations. This would bring its e-money under the regulation of the government, so the e-money would cease to be private. The private e-money provider must therefore operate like a mutual fund, purchasing securities on the primary and secondary markets. This raises the further problem of whether the holders of

securities would accept the private e-money as payment, especially at the inception of the private e-money system.

The different revenue-generating functions of a private e-money provider give an indication of the type of institution that could evolve into a private e-money provider. As Friedman (1999) points out, the key step in creating private e-money is the settling of payments on the books of the private firm rather than on the books of the central bank. Thus, a clearing house or credit card system is a natural candidate to become a private e-money provider. A mutual fund, insurance firm, or another large asset manager could potentially add e-money creation, clearing, and settlement to its services, since it already has expertise in managing deposits and assets and a large base of potential e-money users. Friedman also suggests that a very large provider of some good or service, such as a transportation authority, that accepts e-money, could also potentially create, clear, and settle payments on its own books.

But again a note of caution is in order. It is highly unlikely that a potential e-money provider can suddenly introduce a private e-money that is completely independent of the banking system. In order to establish its reputation, a private e-money provider will have to promise to redeem private e-money liabilities in government money. This means that the private e-money provider will have to maintain deposit accounts at banks. Banks will probably regard a private e-money provider as a competitor for deposits and may refuse to do business with a private e-money provider. This limits the likelihood that a private e-money provider will be a clearing house or a credit card system. Visa, for example, is actually a member-owned association, where the membership includes banks. And a private firm that uses bank loans to finance its activities will probably not want to undertake a venture that will certainly jeopardize this source of funding, regardless of the profitability of the private e-money venture. This leaves the mutual fund company as the most likely introducer of private e-money.

The private e-money function of any provider is likely to mimic the operation of a bank of issue, the last large-scale private money provider, which operated under the gold standard. The private e-money issuer will maintain a reserve of government money (and government-money-denominated assets), and promise to redeem all private e-money deposits in government money on demand if the depositor wishes. If the private e-money provider proves its soundness and reliability, it may reduce its government-money reserves to a smaller and smaller fraction of the stock of private e-money claims that it has issued. In the extreme case, the private e-money provider can reduce its reserves of government money to a trivial fraction of its private e-money liabilities.

In the end, it is unlikely that private e-money will drive out government money, for several reasons. First, households and businesses will be willing to hold both government money and private e-money in their portfolios. Second, the establishment of a private e-money system will likely depend on the use of government money as a reserve by the private e-money provider. And since private e-money providers cannot engage in direct lending, government money will persist through the banking system, as long as there is demand for bank loans.

On the other hand, it is unclear whether private e-money can be introduced successfully and can flourish. Not only is it unclear whether there are sufficient profits to attract potential private

e-money providers, but the type of firm that would be willing and able to provide private e-money also appears to be limited. For now, we assume that sufficient profits and an able provider will arise, so that we can solve the remaining puzzles. But in reality, the requirements for the existence of private e-money appear difficult to meet.

E. Puzzle 5 Solution: A Simple but Crowded Money Market

The preceding analysis suggests that private e-money and government money can coexist, so that along some margin, households and firms are indifferent between them. This enables us to pursue two different strategies for modeling the impact of the introduction of private e-money. In one approach, we can take the indifference between the two monies as given and incorporate private e-money and government money into a single money market and hence into the IS-LM framework. We present this approach first. In the second approach, we can focus on the frontier of indifference between the two monies and see how the two monies interact in order to maintain this indifference, especially in response to monetary policy. This requires the creation of a more complex model. We present this second model after our discussion of the IS-LM framework. As we shall see, the results from the two models complement each other.

Turning to the IS-LM framework, we start with the money market, and in particular, the money demand function. Let us assume that households are indifferent between private e-money and government money, in the sense that they are content to substitute one for the other in all uses. If this is the case, then the money demand function is not changed by the introduction of private e-money. Aggregate money demand will still be a positive function of the level of output, Y, and a negative function of the interest rate r, where r measures an opportunity cost of holding money.

The money supply function will be different after the introduction of private e-money, however. Total money in the economy will be the sum of government money and private e-money. Typically, we assume that the supply of government money is arbitrarily chosen by the central bank. The supply of private e-money, however, is driven by the market. In particular, we reasoned above that private e-money providers will issue their private money in order to make profits by investing the resources deposited with them into assets. As the market return on this asset portfolio rises, private e-money providers will wish to supply more money in order to make more investments and hence earn more profits. Thus, the private e-money component of money supply will depend positively on r, so that the overall money supply function will depend on r.

The traditional formulation of the money market in the IS-LM model uses a vertical money supply to reflect the assumption that the central bank sets the money supply arbitrarily. In the model with private e-money, the money supply curve is now upward-sloping, with the well-known effect of flattening the LM curve relative to the case of a vertical money supply function. What this implies is that as the central bank reduces the supply of government money, interest rates begin to rise, which prompts the private providers to supply more money. Private e-money providers effectively replace some of the government money withdrawn from the system with private e-money, reducing the extent of the monetary contraction.

From the previous description, it is clear that one of the main impact on the economy is that monetary policy will become less effective. This is captured by the flattening of the LM curve. And the introduction of private e-money will increase the overall money supply, shifting the LM

curve down. Thus, the introduction of private e-money exacerbates the trend that began with the introduction of e-banking. In Figure 2, we show the further downward shift and flattening of the LM curve with the introduction of private e-money.

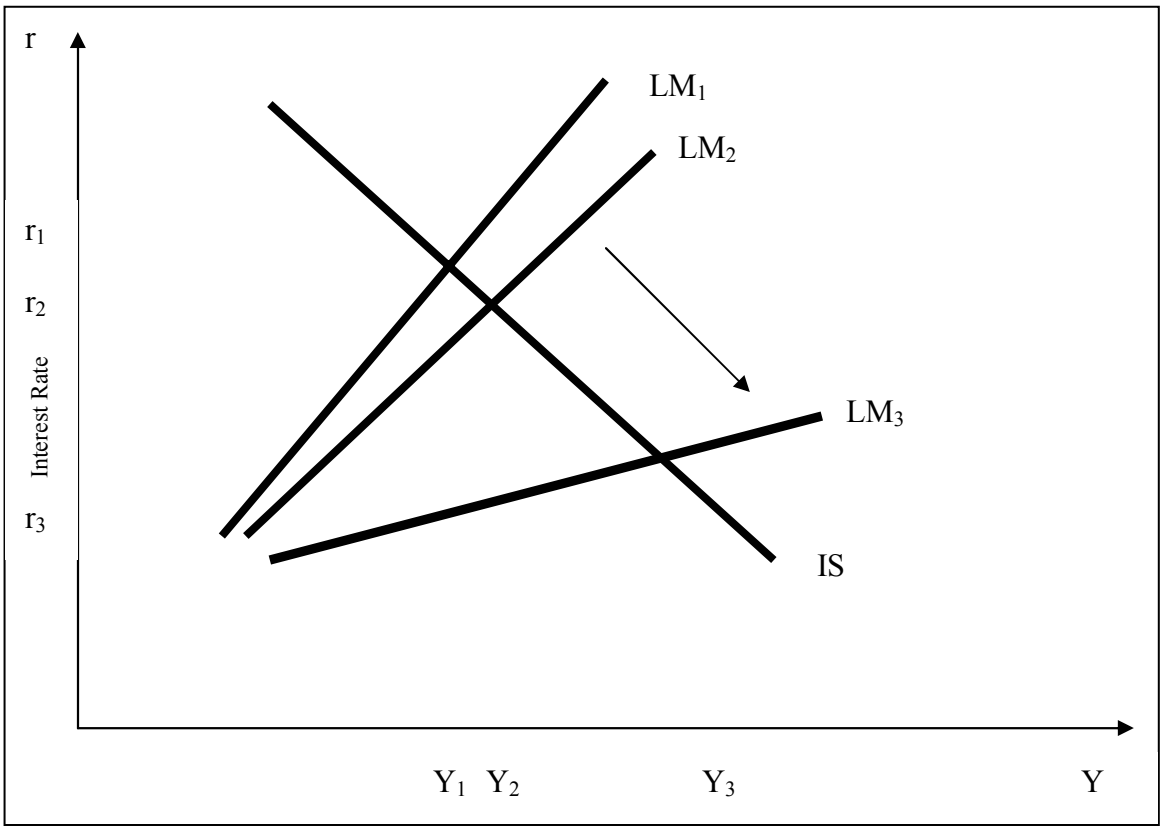
Interestingly, the interest sensitivity of the LM curve will vary depending on the proportions of private e-money and government money in the overall money supply. The central bank will have to resist the urge to aggressively "sterilize" the stimulative effect of the introduction of private e-money, since doing so will only tend to flatten the LM curve and render future monetary policy less effective.

Now we turn to a model of the money market that does not take indifference between private e-money and government money as given.[6] This model includes four interconnected deposit and loan markets, and four players: households, banks (including the central bank), firms, and private e-money providers. This model incorporates most of the specific arguments about the provision of e-money made in the previous section, and it makes banks the main providers of government money. Money in this model exists mainly in the form of interest-bearing checking deposits (currency is not explicitly excluded, but plays no role). Households supply deposits, and they can choose to supply them to banks or to private e-money providers. Banks demand deposits and supply bank loans to firms. Firms demand funding, and have a choice between bank loans or issuing bonds. The demanders of the firms' bonds are the private e-money providers. They demand deposits in order to fund their investments in these corporate bonds. Only private e-money providers purchase bonds in this model, just as only banks offer bank loans, and the only assets available to households are interest-bearing checking accounts held at banks or with private e-money providers.

The monetary system is therefore made up of four markets. Figure 3 shows the four markets that make up the money system in this model. First is the market for private e-money. Private e-money will exist, as argued above, in the form of interest-bearing checkable deposits. The private e-money provider will be the demander of deposits, while households and firms will supply these deposits. The supply of deposits depends positively on the aggregate level of income, Y, as well as the rate of interest offered on private e-money deposits, r_P, and it depends negatively on the rate of interest offered on government e-money deposits, r_G. The demand for private e-money deposits depends negatively on the rate of interest paid on these deposits and positively on the rate of return on bonds, r_B, since the private e-money provider profits from the spread between the bond return and the interest rate paid on e-money balances.

[6] The model is based on the banking model in Miller and VanHoose (1993).

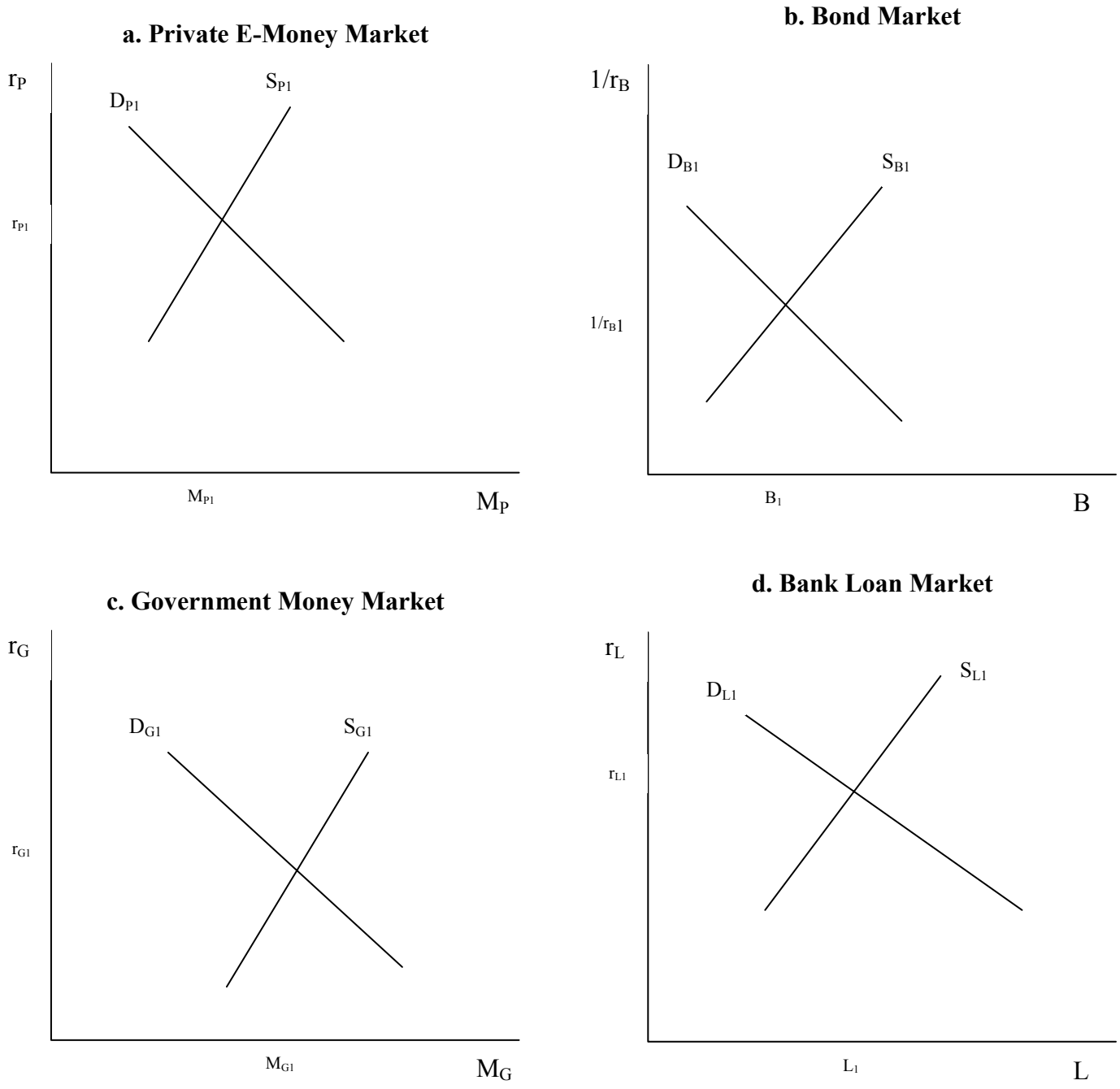
Figure 2
Combined Effect of E-Banking and Private E-Money



The second market is the bond market. Bonds are supplied by firms wishing to borrow from the capital markets, and are demanded by the private e-money providers.[7] If we let r_B denote the rate of return on bonds, then the demand for bonds depends negatively on $1/ r_B$ and the supply of bonds depends positively on $1/r_B$. In addition, the supply of bonds depends negatively on the rate of interest on bank loans, r_L, while the demand for bonds depends negatively on r_P.

[7]We limit bond market lending to private e-money providers for simplicity. Allowing households and banks to purchase bonds does not affect the qualitative results.

Figure 3
Money Market Model



The third market is the market for government money. This is analogous to the market for private money, so that the money is in the form of interest-bearing checkable deposits demanded by banks and supplied by households. The demand for deposits depends negatively on $r_{G,}$ the rate of interest paid on government money, and positively on r_L. The supply of deposits depends positively Y and r_G, and negatively on r_P. In addition, we let the supply of deposits depend positively on the aggregate quantity of reserves, R, supplied by the central bank. Reserves are included in the bank's deposit supply function in order to allow monetary policy to play a role. We could also specify a reserve requirement, and a market for bank reserves, but this would needlessly complicate the model relative to our purposes. Instead, we simply assume that reserves are exogenously set by the central bank and affect the supply of government-regulated deposits positively.

The fourth market is the market for bank loans. Banks supply the loans, while firms demand them. The supply of bank loans[8] depends positively on the rate on bank loans, r_L. The demand for bank loans depends negatively on r_L and positively on r_B.

The money market model allows us to examine the monetary transmission mechanism in an economy in which both government and private e-money exist. By making the supply of bank deposits depend positively on the quantity of aggregate reserves supplied by the central bank, we are able to capture the effect of an injection or withdrawal of high-powered government money. The markets are linked together in two main ways. First, private e-money providers participate in both the private e-money and the bond markets, while banks participate in both the government money and loan markets. In addition, the markets are linked by competition between the bank loan and bond markets for borrowers as well as competition between the private e-money and the government e-money markets for depositors. Notice that the model does not assume that private e-money providers demand government money for their reserves, as discussed above.

To see whether the central bank can still maintain monetary control in the presence of private e-money, we trace the effects of an injection of high-powered government money through the above model. This is a comparative statics exercise, but with many intermediate steps, so we walk through the connections sequentially (and only partially) in two diagrams, Figures 4a and 4b. Suppose the central bank increases the amount of reserves and hence the supply of bank deposits. This shifts the supply of government-regulated deposits outward, increasing the quantity of deposits and reducing the interest rate r_G . This is shown in the Government Money Market in Figure 4a. The change in this deposit rate then affects two other markets. In the loan market, it increases the supply of loans, increasing the quantity and decreasing the loan rate r_L. This occurs because the bank deposit rate is part of the marginal cost of making loans. In the private money market, the drop in r_G increases the supply of private money

[8] Technically, since this is a marginal cost curve, we need to assume that there are real resource costs of administering loans that increase with the quantity of loans. Similarly, we also need to assume that there are real resource costs of administering deposits that increase with the quantity of deposits.

Figure 4a
Effects of an Injection of High-Powered Government Money

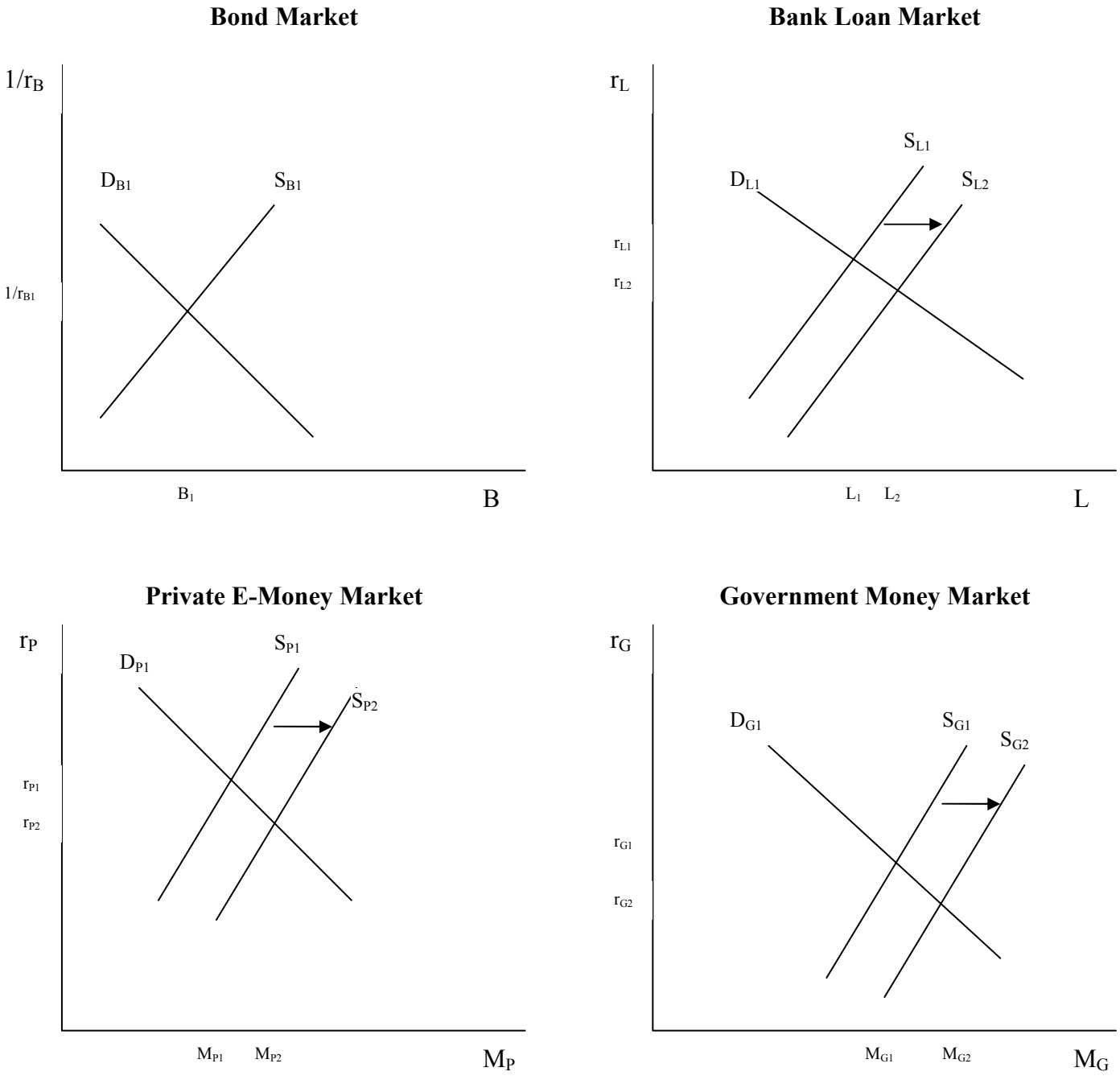
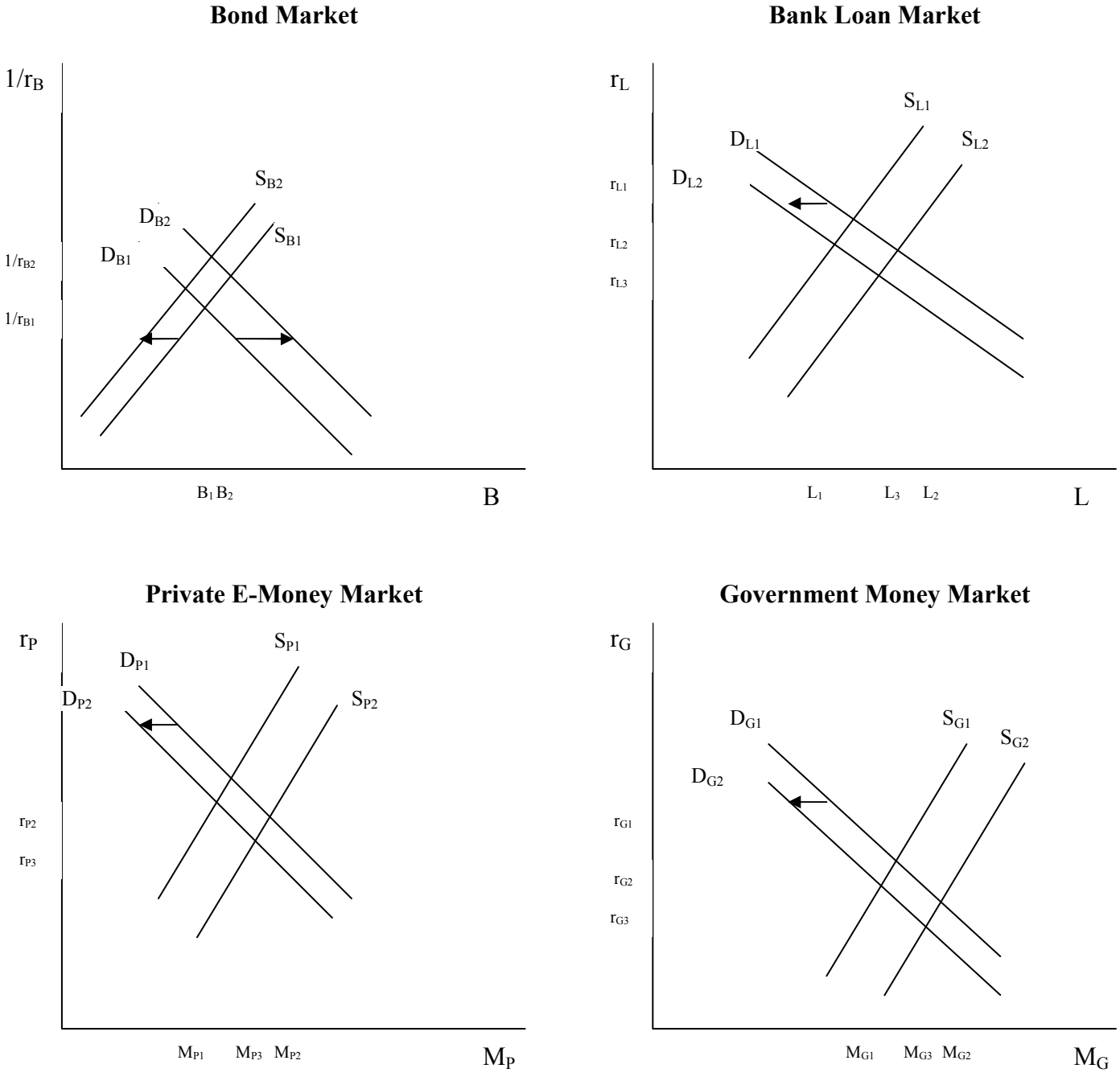


Figure 4b
Further Effects of an Injection of High-Powered Government Money



deposits, increasing their quantity and lowering r_P, since households would rather allocate more of their portfolios to the higher-yielding private deposit accounts. These two effects are also shown in Figure 4a.

The effects in the loan and private deposit markets then spread to other markets, and these effects are shown in Figure 4b. In the bond market, the drop in r_L decreases the supply of bonds, since borrowers would prefer to borrow at the lower bank loan rate. Meanwhile, the drop in r_P increases the demand for bonds, since this increases the money provider's marginal profit on bond purchases. These reactions will raise $1/r_B$, or in other words will lower r_B. The fall in the bond rate in turn causes the demand for bank loans to decline. This pushes the loan rate down further and reduces the quantity of bank loans. The fall in the bond rate also causes the demand for private deposits to decline, since the bond rate is the marginal return to accepting private deposits. Similarly, the decrease in the loan rate decreases the demand for bank deposits, since the loan rate represents the marginal revenue from taking an additional unit of deposits.

At this point, due to connections between the markets, all the supply and demand curves have shifted once and we have come full circle in the sense that the decrease in demand for bank deposits will lower r_G and touch off another round of adjustments.[9] But as prices continue to change in the various markets, the curves will continue to shift, implying that quantities and prices continue to adjust. The feedback effects continue until equilibrium is reestablished, which occurs when the quantity of government deposits once again equals the quantity of bank loans and the quantity of private deposits equals the quantity of bonds. This will be assured if we impose some reasonable stability conditions that make the successive shifts of the curves die out.

When the feedback effects die out, the new equilibrium will have two main characteristics: interest rates in the deposit markets will be lower, and the total quantity of money will be greater. This is the same qualitative result that obtains in an economy with government money only. But in this case, part of the government-money stimulus is converted to private e-money. This is a leakage that the government cannot prevent. This leakage, as we have seen above in the IS-LM model, reduces the effectiveness of monetary policy. The practical upshot is that the central bank will have to use a larger impulse than before to obtain its desired results. But again, the central bank does retain monetary control and autonomy. Although the chain of events is complex, the central bank can reestimate the reactions of both the banking system and the private e-money market to the government-money stimulus, and base its policy on these new estimates of the combined money market reaction. While the central bank's job has become more complicated, it remains possible to manage the aggregate quantity of money and market interest rates.

[9] We have omitted several additional spillovers in the interest of clarity. Doing so does not affect the qualitative result.

F. Puzzle 6 Solution: Making E-Money Providers Pay to Play

Now we come to the final puzzle: what should be done about private e-money? Is it a useful innovation, a nuisance akin to spam email, or an attack on the monetary system that must be prevented by some kind of firewall or antivirus software? Clearly, since private e-money (to the extent that it exists) will be part of the payment system, the central bank must be concerned about the emergence and uses of private e-money and the dangers that a private e-money system poses.

Fundamentally, there are two possible threats from private e-money. The first one constitutes Puzzle 5—will private e-money destroy the central bank's ability to manipulate the money supply or to affect output and interest rates in the short run? We have used the IS-LM model, and our four-market model in turn, to argue that this will not be the case. The monetary authority will have to pull harder on the policy levers, but they will still have an effect. But it may be argued that our model assumes that the private e-money providers will be well behaved, even in the absence of government regulation. We have not considered, for example, that a private e-money provider could become reckless in its issuance of private e-money, which could lead to inflation or to financial panic. The historical experience with unregulated financial institutions, however, indicates that this is a naïve assumption.

The latter consequence is the real danger of private e-money. Private e-money could pose a huge systemic risk if left unregulated. Overissuance of private e-money could lead to a classic run on the private provider, or it could introduce gridlock into the payment system if private e-money payments are suddenly refused. Such problems will surely spill over into the banking system and other financial markets, given the various linkages between private e-money, government money, and the bond market that we modeled in this paper. A financial panic precipitated by private e-money would place the central bank in a difficult position. On one hand, such a panic would effectively and more or less permanently eliminate private e-money, but at a potentially huge cost to the government money system and to the real economy. On the other hand, if the central bank were to use its power as lender of last resort, the action may unintentionally bail out the private e-money provider and create a moral hazard problem.

The goal of regulation should be to reduce or eliminate the systemic risk from private e-money. One strategy is to prevent private e-money from appearing in the first place. An outright ban on private e-money is possible, but as in the case of state bank notes, perhaps a more successful strategy would involve taxing the issuance or use of private e-money at a rate that makes it unprofitable or unattractive. But should private e-money be eliminated? As mentioned above, private e-money must find a niche in order to be adopted by households and firms. It must fulfill the functions of money in a way that is better, faster, or cheaper than government money. If private e-money providers find a way to do this, it would represent a valuable innovation in the payment system that would probably have to be mimicked by the government e-money system. Private e-money could provide a force for payment system innovation and improvement that is largely missing from many economies, most notably the United States, which is still mired in billions of paper cheques. If private e-money can be managed to gain the benefits of increased competition and payment innovation without an

unacceptable increase in systemic risk, then private e-money does have a useful role to play in the economy.

The question of regulation then becomes whether it is possible to manage private e-money providers to limit systemic risk. One possibility is simply to impose regulation on them as on any other financial institution. Private e-money providers are essentially modern banks of issue, so one possibility is to create a special regulatory category for such an institution and to modify the banking regulations to accommodate them. Such regulations would include capital adequacy, and the Basel standards could easily be extended to these banks of issue. Issuance of private e-money can likewise be regulated by the imposition of CAMELS-like ratings and standards for private e-money providers.

One potent tool for regulating private e-money providers, which has a precedent in history, is to force them to redeem their private e-money for government money in large quantities, on a regular basis. This technique was used by the First and Second Banks of the United States in the early 19th century as a way to regulate the issuance of private bank notes. The Bank of the United States would accumulate claims against state banks, in the form of their notes, and present them to the issuing banks for redemption in specie. According to contemporary observers, this regulation was fairly successful at keeping state bank note issuance in check. Such a practice could work well for modern regulators of e-banks, and it would obviate a policy advocated by some authors. In particular, Goodhart (2000) has advocated that the government only accept government money as payment in order to maintain demand for government money and hence to maintain monetary control. But if the central bank were to redeem private e-money payments for government money on behalf of the finance ministry, this would accomplish the purpose just as well. In fact, it would be a better practice, because it involves the central bank directly in monitoring and disciplining the private e-money issuers.

One question that remains with regard to regulation is whether e-money is governable in the long run. That is, if a government bans the provision of private e-money, or allows it under conditions that prospective providers find unacceptable, renegade providers may attempt to establish an illegal private e-money system, say in an offshore server. Given our analysis, it seems that e-money is governable in the long run, even though monetary policy as practiced over the past 50 years may lose its effectiveness. What we have shown is that e-money is tied intimately to e-banking, and banks are still delicate institutions that depend on trust and reputation as much as convenience and price of services. Renegade e-money providers will lack trust, reputation, and convenience, because they will have to remain completely separate from the official money and payment system. Therefore, they are not likely to survive.[10]

The above point actually raises a possible outcome from regulation. We have argued that private e-money providers will be like banks in that they are highly leveraged institutions that operate on small margins and are therefore quite sensitive to changes in their cost structure.

[10] Of course, if the credibility of the government money system has already been destroyed, they may well be able to thrive. We leave this possibility to future research.

Thus, as with other financial institutions, it will remain surprisingly easy to regulate them out of existence by imposing costs on them. In addition, competition from government money providers—banks—is likely to be intense as they fight to protect their franchise over money creation. It is quite probable that the establishment of minimum capital standards, combined with the costs of entry into a market with a strong incumbent firm, will be sufficient to prevent private e-money providers from arising, even though they would be perfectly legal.

V. CONCLUSION

In this paper, we have clarified the main issues raised in the literature on e-money and e-banking, which we have presented as six puzzles. Several of the puzzles arise simply because the literature has tended to gloss over the mundane issues, such as definition of terms, and instead rushed to explore the most interesting and provocative aspects of the topic. While this is understandable, it is now time to step back from the realm of the possible and carefully consider what is actually likely, given the current state of technology and the demands of market participants. By solving the six puzzles, which build on each other, we construct a picture of the most likely future impact and policy challenges that will arise from the adoption of e-banking and e-money.

This exercise provides several important insights into e-money and e-banking that will be useful to policymakers. First, we have provided clear and inclusive definitions of e-banking and e-money. These definitions remind us that both e-banking and e-money have existed for quite a while, which forces us to find the truly new innovations in each area. We argued that the innovation in e-banking is the adoption of Internet e-banking, and that the innovation in e-money is the creation of private e-money. These innovations are the sources of the most significant effects, including potential problems, from e-banking and e-money.

The second insight from this exercise is that the adoption of Internet e-banking has an important implication for monetary policy: monetary policy will become less effective as money holdings become increasingly interest sensitive, because of Internet e-banking. The impact of this change has been incremental, since the widespread adoption of Internet e-banking is likely to take place over many years. Nonetheless, the cumulative effect may be quite large and may significantly reduce the effectiveness of monetary policy as currently practiced. There is also a benefit to this process in the form of expansionary pressures in the economy that raise economic activity while allowing interest rates to remain low.

Our exercise yields a similar insight into the effect of the introduction of private e-money. Private e-money will coexist with, and interact with, government money. Given the economics of private e-money creation, the overall money supply will become more responsive to interest rates, which reduces the effectiveness of monetary policy. Another way to interpret this is that the activity of private e-money providers will partially offset the monetary policy action taken by the central bank. When the central bank reduces the (growth rate of the) money supply, private e-money providers will see a profit opportunity and fill at least part of the gap created by monetary policy. Depending on the "transaction space" for private e-money, and the viability of the private e-money providers, the reduction in monetary policy effectiveness can be far greater than the impact of the adoption of Internet

e-banking. Friedman's scenario (1999; 2000), in which the central bank becomes irrelevant at the margin, remains a nontrivial possibility.

Finally, to the extent that private e-money provides socially useful services, it should not be quashed by government regulation. But private e-money providers will also be financial institutions—ones that will come to play a key role in the payment system. Thus, regulation of these institutions is essential. One strategy would be to redefine what a bank is, based on the role an institution plays in the payment system. This would make it impossible to operate as an e-money provider without being a bank, since clearing payments is intrinsic to operating a private e-money system. The effect of this change in definition would be to eliminate all private e-money by bringing it under the monetary control activities of central banks, effectively converting it to government e-money.

On the other hand, private e-money providers do not need to be banks (as currently defined) or to be regulated exactly like commercial banks. They do need to be prevented from overissuing money that would lead to default and payment system gridlock. This can be done through appropriate capital requirements and CAMELS-like ratings created specifically for modern banks of e-issue. In addition, private e-money providers can be required to redeem their e-money for government e-money at par and can enforce convertibility by "presenting" massive quantities of private e-money for redemption on a regular basis. The central bank can regulate safety and soundness of banks of issue and participate in market discipline. By simply establishing standards for safe and sound operation, however, there is a good chance that regulation will render private e-money provision unprofitable.

Of all the possibilities we consider in this paper, the most likely scenario appears to be that e-banking will give the economy a repeated, mild stimulus while gradually weakening the effectiveness of monetary policy. Internet e-banking is a reality that is gaining momentum. On the other hand, it remains to be seen whether sound, safe, and profitable private e-money providers can thrive outside the imagination of economists. Nonetheless, regulators should be prepared for this possibility.

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