Federal Reserve Bank of Minneapolis Quarterly Review
Vol. 20, No. 3, Summer 1996, pp. 3–10

Will the New $100 Bill Decrease Counterfeiting?

Edward J. Green
Senior Research Officer
Research Department
Federal Reserve Bank of Minneapolis

Warren E. Weber
Senior Research Officer
Research Department
Federal Reserve Bank of Minneapolis

Abstract

A current U.S. policy is to introduce a new style of currency that is harder to counterfeit, but not immediately to withdraw from circulation all of the old-style currency. This policy is analyzed in a random matching model of money, and its potential to decrease counterfeiting in the long run is shown. For various parameters of the model, three types of equilibria are found to occur. In only one does counterfeiting continue at its initial high level. In the other two, both genuine and counterfeit old-style money go out of circulation—immediately in one and gradually in the other. There are objectives and expectations that can reasonably be imputed to policymakers, under which the policy that they have chosen can make sense.

Earlier this year, the Federal Reserve System and the U.S. Treasury introduced $100 bills that are printed in a new style. These new-style bills are much more difficult and expensive to counterfeit convincingly than the old-style bills, and the main reason for introducing them is a desire to decrease counterfeiting. The U.S. government is emphasizing that old-style bills will still be honored, though. They are being removed from circulation by a process that could take years to complete.[1] Superficially, then, it seems that this policy—introducing new-style bills, but not aggressively withdrawing old-style bills from circulation—might not achieve its aim of decreasing counterfeiting until the last genuine old-style bill is gone. Although we do not show that the current policy will necessarily be effective in the near term, we do show that a long-term failure cannot be taken for granted. Thus, the U.S. policy is not self-defeating, as it seems on first sight. There are objectives and expectations that can reasonably be imputed to policymakers, under which the policy they have chosen can make sense.

Specifically, we analyze the effects of the introduction of new-style money on the counterfeiting of old-style money in a random matching model, where genuine old-style money is acceptable as legal tender forever. We find that three types of equilibria exist in this model economy. In one, counterfeiting persists; in others, counterfeiting stops, either immediately or after some period of time.[2] We find conditions under which the U.S. policy has the best chance to be effective, although we cannot say unconditionally that the policy will lead to the elimination of counterfeiting. Moreover, we show that even a successful policy may not have an immediate effect. Counterfeit money may continue to be produced for some time after the policy is introduced, and counterfeit money may be acceptable in trade forever, even though it will asymptotically stop circulating.

Since counterfeiting persists in some equilibria but not in others, what can we learn from the equilibrium analysis? Actually, we learn three things of interest. First, as we have already pointed out, we learn that an equilibrium does exist in which counterfeiting stops at some date. Thus, the failure of the U.S. policy is not inevitable. Moreover, the realization that counterfeiting can stop eventually, although it does not stop immediately, may prevent people from making a premature judgment that the introduction of new-style money has failed to achieve its purpose.

Second, we learn that a necessary condition for the existence of an equilibrium with persistent counterfeiting is that the probability of confiscation cannot be too high.[3] In other words, an aggressive effort to confiscate counterfeit bills can stop counterfeiting, and such government effort may be necessary. Thus, the model shows that, at least for some parameter values, continued confiscation of old-style counterfeit is an essential complement to the introduction of new-style money. However, our analysis also shows that the level of confiscation effort needed to stop counterfeiting may be lower when new-style money is introduced concurrently than it would have to be otherwise.

Third, we learn from the model that the introduction of the new-style money does not necessarily mean that the old-style money will immediately go out of circulation in the sense of being refused in transactions. In fact, we show a case in which the old-style money always remains in circulation in this sense. Thus, the analysis shows that the old-style money can be withdrawn from circulation on a smooth time path, so that the quantity of money acceptable in trade does not decrease abruptly. This is perhaps not directly relevant to the U.S. domestic economy. However, the large holdings of U.S. currency in some foreign countries adds a further dimension to the problem. For instance, a U.S. foreign policy objective is to foster economic stability in Russia, where more than a quarter of the real value of the total currency stock consisted of old-style U.S. $100 bills at the start of 1996.[4] Pulling these bills from circulation abruptly would be an even more extreme monetary contraction than the severe one that occurred in the United States at the beginning of the 1930s depression. Many policymakers would worry deeply about the macroeconomic consequences of such a contraction, especially in a country where there are already public-finance difficulties that would complicate the use of fiscal policy to mitigate the shock. In view of such concern by policymakers, our model can help explain how the new U.S. currency policy can have been chosen rationally.

The Environment

To study the new policy, we formulate and analyze a *random matching model* of money, in which agents are randomly matched into pairs and use money to make trades that would otherwise not be made.[5]

There are two types of agents. One type is *private agents*, or *traders*, each of whom is able to (costlessly) produce and store one commodity but wants to consume only another commodity.[6] We assume that there are T types of traders, who are indexed by the commodity they want to consume. Specifically, a trader of type j wants to consume only commodity j and can costlessly produce a unit of type $j + 1$, which can then be traded for money in the future. (We adopt the convention that $T + 1 = 1$.)

The other type is *government agents*, who do not consume anything and do not maximize their own utility (or even have a utility function). Rather, these agents follow a prescribed rule for replacing genuine old-style money with new-style money and confiscating counterfeit money in a way more fully described below. The fraction of agents in the economy who are government agents is S.

The use of money is essential for trade to occur in this model. Barter is ruled out, because the seller of a commodity will never want to consume the specific commodity the buyer could provide in return. Our assumption about storage also makes it infeasible for a trader to carry inventories of all the various commodities that are traded, so that only intrinsically worthless (but easily storable and transferable) fiat objects can become universally acceptable in trade. A seller accepts such objects, which are the monies in our model, if they can be given in turn to another seller who offers what the current seller desires to consume. This trade takes place when the current seller is subsequently paired with an appropriate trading partner and takes the role of buyer. We assume that both commodities and money objects are indivisible.

In our model, three types of money objects might serve as fiat money: genuine old-style money (denoted G); counterfeit, or bad, old-style money (B); and new-style money (N). We assume that government agents can identify all three types with perfect accuracy. Traders can identify new-style money, but we assume that they are completely unable to distinguish between genuine and counterfeit old-style money when either is presented in trade. If traders do accept counterfeit money, though, then they are able to recognize it after making a close inspection. Based on some news reports, we believe that this assumption accurately reflects the predicament of the public in places like Russia and the Middle East today.[7]

All agents are infinitely lived, and they are randomly matched into pairs at each date. Because there are infinitely many agents, no pair ever meets twice. Whenever two private agents are matched with each other, they must decide whether or not to trade the objects (commodities or money) they are holding. Trade occurs only if both traders agree to it. When a trader succeeds in buying a unit of the desired commodity, that trader enjoys an amount u of utility from its consumption. Traders each maximize the expected discounted utility of the random consumption stream they get from participation in the trading process. The discount factor is $1/(1+\rho)$, corresponding to a real interest rate of ρ.

In our model, a trader's life is basically a repetitive sequence of producing a unit of a commodity the trader does not want to consume, exchanging it for a money object with someone who does want to consume it, exchanging the money object for a unit of a commodity that the trader does want to consume, and then producing another unit of the first commodity as a consequence.

To this description of a trader's life, we add a description of what happens in meetings with government agents. Whenever a trader is matched with a government agent and the trader is holding either genuine or counterfeit old-style money, the government agent confiscates it. The government agent then gives a unit of new-style money to a trader who was holding genuine old-style money, but gives nothing to a trader who was holding counterfeit. If a trader's counterfeit is confiscated by a government agent, the trader can either replace the counterfeit or not. Replacement requires the trader to pay a utility cost c, which is borne by the trader at the time the counterfeit is confiscated. We assume that a trader who chooses not to produce a new unit of counterfeit can never trade again, because that trader has neither a commodity nor money. What determines whether or not a trader chooses to produce replacement counterfeit after confiscation is the essence of what we study here.

States, Strategies, and Equilibria

As a trader participates in the process of matching and trading we have just described, that trader goes through a sequence of states that are defined by what object is being held. At any time, the trader might be holding that trader's produced commodity (state 0), genuine old-style money (state G), counterfeit money (state B), or new-style money (state N). The trader might also be holding nothing, if previously held counterfeit has been confiscated and has not been replaced.

A trader's *exchange strategy* at a given time is a policy that specifies, for each type of object possibly being held, what other types of objects the trader is willing to exchange for it. Most importantly, the exchange strategy specifies which types of money objects the trader is willing to exchange for the produced commodity. (Money objects are simply old-style and new-style money, since the trader cannot distinguish between genuine and counterfeit old-style money.) Let $\lambda_{ij} = 1$ denote that the trader is willing to move from state i to state j; $\lambda_{ij} = 0$ otherwise. For example, $\lambda_{01} = 1$ indicates that a trader is willing to trade a commodity for old-style money, and $\lambda_{G0} = 0$ indicates that a trader is not willing to trade a unit of genuine money for a commodity.

Besides having an exchange strategy, at each time, a trader must have a *counterfeiting strategy* to determine whether or not to make a new unit of counterfeit if the trader is in the situation of holding neither a commodity nor money. (Presumably, this situation would be caused by having had counterfeit confiscated by a government agent.) Let $\gamma = 1$ be a decision by a trader to produce a new unit of counterfeit after having existing counterfeit confiscated in a meeting with a government agent; $\gamma = 0$ otherwise. A trader's *comprehensive strategy* is an exchange strategy and a counterfeiting strategy to be followed by each trader.

A *Nash equilibrium* is a comprehensive strategy that each individual trader would adopt if that trader were sure that every other trader had also adopted it. A *steady-state equilibrium* is one in which traders' strategies do not change over time. Whenever we refer below to an *equilibrium* of our model, we mean specifically a steady-state Nash equilibrium. The way in which we solve for an equilibrium is shown in Green and Weber 1996.

A Model Without New-Style Money . . .

As a starting point for our analysis of counterfeiting, consider an economy with only one type of genuine money, which traders cannot distinguish from counterfeit. Assume that government agents confiscate counterfeit, but that they do nothing when they meet a trader holding genuine money. Except for these simplifications, this economy works just like the more general one that we mainly intend to study. In particular, traders cannot distinguish genuine money from counterfeit when they make purchases, and traders whose counterfeit is confiscated have to decide whether or not to replace it.

Since we want to use this simplified model as a starting point for the analysis of the effects of introducing new-style money, we will consider only an economy for which these two conditions are satisfied: (1) There is a unique equilibrium with strictly positive stocks of both genuine and counterfeit money in which sellers accept money in exchange for commodities. (2) In this equilibrium, a trader holding counterfeit always chooses to replace it after confiscation. We require this condition in order to have a positive stock of counterfeit money in existence in the steady state.

In this economy, the value to a trader of having a unit of counterfeit, V_B, given that money is acceptable in trade, is

$$(1) \qquad V_B = \{(\rho+g+b)(\rho+k)ku - [(\rho+b)(\rho+k) + \rho g]Sc\} \div [\rho(\rho+g+b+k)(\rho+k)] > 0$$

where g, b, and k are the fractions of traders who hold genuine money, counterfeit money, and commodities, respectively, and who are of a given type. The following proposition, which is proved in Green and Weber 1996, shows that parameter values exist for which traders will replace confiscated counterfeit in such an economy.

PROPOSITION 1. *If*

(2) $V_B > c$

then a steady-state Nash equilibrium exists with money offered and accepted in trade ($\lambda_{01} = \lambda_{G0} = \lambda_{B0} = 1$) *and with confiscated counterfeit money replaced* ($\gamma = 1$).

Given our assumptions about the environment that rule out barter and that force traders to engage in trade in order to enjoy any utility, accepting money for one's produced commodity is the only option for participation in exchange. Thus, by itself, the acceptability of money implies no restriction on the parameter values for the economy.

In contrast, traders' willingness to replace confiscated counterfeit is restrictive. It requires condition (2) in Proposition 1 to be satisfied. In deciding whether or not to make a replacement, traders weigh the expected utility from the consumption they can get with a unit of counterfeit, V_B, against the immediate utility cost, c, of making the replacement. The higher c is, the more likely it is that this cost will be higher than the expected utility and that traders will choose not to replace the counterfeit. Further, traders' expected utility depends negatively on the fraction of agents in the economy who are government agents, because the larger S is, the more likely it is that traders will have their counterfeit confiscated before being able to trade it for commodities. Thus, the higher S is, the less likely it is that traders will be willing to replace confiscated counterfeit.

. . . And With New-Style Money

We now turn to our main model, in which government agents exchange new-style money for genuine old-style money in their randomly paired meetings with traders. Eventually, genuine money will be perfectly distinguishable from counterfeit under this scheme, because in the limit, the stock of genuine money becomes new-style money. Here we start from the steady state described in the last section, in which confiscated counterfeit is being replaced, so that (2) is satisfied. We show two possible outcomes, both of which depend on the parameters of the economy: either the introduction of new-style money will have no effect on counterfeiting or it will lead to the eventual elimination of counterfeiting.

The following proposition, which is proved in Green and Weber 1996, shows the conditions under which the introduction of new-style money might not eliminate counterfeiting of old-style money. Let n be the fraction of agents who hold new-style money and are of a given type. Since in the steady state, all genuine old-style money will be replaced by new-style money after its introduction, $n = g$.

PROPOSITION 2. *If* (2) *is satisfied and*

(3) $(\rho+k)ku/[(\rho+n+k)S] > c$

then a steady-state Nash equilibrium exists with both old- and new-style monies offered and accepted in trade ($\lambda_{01} = \lambda_{G0} = \lambda_{B0} = \lambda_{N0} = 1$) *and with counterfeit money replaced* ($\gamma = 1$), *although the equilibrium may not be unique.*

This proposition shows that two conditions must be satisfied in order for counterfeiting to continue after new-style money is introduced. Condition (2) is that traders find it in their interest to replace counterfeit after it has been confiscated. This condition is satisfied after the introduction of new-style money, because we have assumed that the economy started from a steady state in which it was.

In order for the introduction of new-style money to have no effect on counterfeiting, sellers must have an incentive to accept counterfeit, even though in the steady state they know that they are getting counterfeit. Condition (3) guarantees that this will be true. Why would sellers knowingly accept counterfeit? Recall that in this economy, traders only obtain utility if they are able to trade their commodities for money and then trade money for the commodities they want to consume. Recall also that waiting for consumption is costly. If there is not much genuine money in the economy, then a seller would expect to wait a long time before meeting a trader with a unit of it. In such a case, a seller might knowingly accept a unit of counterfeit and accept the possibility of it being confiscated, rather than bear the cost of waiting to encounter a buyer with new-style money. Therefore, the smaller n is, the more likely it is that condition (3) will be satisfied.

We have demonstrated that under certain conditions, the introduction of new-style money may have no effect on counterfeiting. We now examine cases in which the introduction of new-style money can lead to the elimination of counterfeiting. One case is that in which traders would not knowingly accept counterfeit; that is, the parameters of the economy do not satisfy condition (3). In this case, the introduction of new-style money must lead to the elimination of counterfeiting in the steady state. Why? Suppose that confiscated counterfeit continues to be replaced as new-style money replaces genuine old-style money. Eventually, traders will know that any old-style money being offered in trade must be counterfeit. Thus, in the steady state, no old-style money will be accepted in trade, which would make it worthless. Obviously, utility-maximizing traders would not pay the cost c to replace something worthless, so confiscated counterfeit would not be replaced, which contradicts the supposition. Inspection of condition (3) shows that the larger the fraction of genuine old-style money is when new-style money is introduced, the more likely this outcome is to occur. (Recall that $n = g$.) Also more likely is the possibility that a trader will encounter a government agent and have counterfeit confiscated.[8]

However, the introduction of new-style money could also lead to the elimination of counterfeiting even if traders would knowingly accept counterfeit. This is shown in the following proposition.

PROPOSITION 3. *If*

(4) $V_B < c$

and

(5) $\rho(\rho+k) > nS$

then a steady-state Nash equilibrium exists with both old- and new-style monies offered and accepted in trade ($\lambda_{01} = \lambda_{G0} = \lambda_{B0} = \lambda_{N0} = 1$), *but without replacement of confiscated counterfeit* ($\gamma = 0$).

Condition (4) is that replacing confiscated counterfeit does not pay. Since we started from an economy in which (2) is satisfied, it may seem as if (4) cannot be. That is not so. If counterfeit is replaced, then V_B in the steady state is given by (1) with b equal to whatever the quantity of counterfeit happens to be. However, if counterfeit is not replaced, then V_B in the steady state is given by (1) with b equal to zero, since there will be no counterfeit in the steady state in such a case. Thus, as long as $ku > (\rho+S)c$, both conditions can be satisfied. This is why we said that the equilibrium in Proposition 2 is not necessarily unique.

Condition (5) is that a seller will accept old-style money even knowing it is counterfeit. This condition is more likely to be satisfied the smaller the stock of new-style money and the smaller the probability of a seller meeting a government agent (the slower the rate at which old-style money is being replaced).

From Propositions 1 and 3, we see that before the introduction of new-style money, the economy could be in a steady state in which money is used in trade, and even though the government is confiscating counterfeit at rate S, it is being replaced as rapidly as it is confiscated. From Proposition 2, we see that if condition (3) is satisfied, the economy could remain in this steady state after new-style money is introduced. From Proposition 3, however, we see that in the same circumstances, the economy can move to a steady state in which old-style money continues to be acceptable in trade, but in which counterfeiting no longer takes place.

If the economy moves to the no-counterfeiting steady state with old-style money acceptable in trade, will the transition be immediate, or will it take some time? We are not able to answer this question analytically, but we have computed equilibrium paths of the economy for various parameter values. The details of the simulation are given in Green and Weber 1996. Here we discuss some features of a typical simulated equilibrium path, which are shown in Charts 1–4. The horizontal axis of each chart is time, which we show for 550 periods.

- The probability that traders are willing to exchange their produced commodities for old-style money is one at all times, since we choose the parameter values such that condition (5) is always satisfied. (See Chart 1.)
- The probability that a trader will replace confiscated counterfeit is one until the critical date 426, after which it is zero. (See Chart 2.)
- Over time, the stock of counterfeit remains constant at the initial level until the critical date, since counterfeit is being replaced until then, but thereafter the stock falls sharply, because counterfeit is being confiscated without replacement. (See Chart 3.)
- The values of holding counterfeit, V_B, and of holding other (new-style and genuine old-style) monies all decline after the critical date. The values also decline from the initial date to the critical date, although the rate of decline is barely perceptible. (See Chart 4.)

There is, of course, a relationship between the behavior of V_B and the behavior of the time path γ. As long as V_B is greater than c, traders will replace confiscated counterfeit, and $\gamma = 1$. Once V_B falls below c, however, traders no longer replace confiscated counterfeit, and $\gamma = 0$. In our example, this switch occurs at the critical date 426.

This simulation shows that in order for the eventual elimination of counterfeiting to occur, V_B must decline over time. We can explain, intuitively, why this decline would occur. Until the critical date, the total money stock remains constant, because genuine old-style money is being replaced one-for-one with new-style money, and counterfeit is being replaced whenever it is confiscated. However, the critical date is approaching, so the expected discounted present value V_B weights the utility of participation in the economy after the critical date more and more heavily. If the utility of participation declines after the critical date, then the weighting causes it to decline before the critical date as well. The utility of participation (and hence V_B) does decline after the critical date, because the total money stock is falling after the critical date due to the nonreplacement of confiscated counterfeit. Because of this decline, the number of traders holding money is decreasing, while the number of traders holding commodities is not increasing correspondingly, because the traders who suffer confiscation live in autarky thereafter. (Note that the decline in the number of money holders due to the falling nominal stock of counterfeit reflects indivisibility.) Therefore, finding trading partners takes progressively longer. This deterioration of the trading environment causes the value of every phase of participation in the economy, including the holding of counterfeit, to decline.

Conclusion

This article is motivated by a desire to understand a new U.S. policy: the introduction of a new-style $100 bill that is more difficult to counterfeit along with the lack of any deadline for private holders to exchange old-style money for new-style. Superficially, this policy combination seems to do nothing to decrease the continued counterfeiting of old-style bills. We find that, despite this appearance, the policy can potentially help to decrease counterfeiting in a way consistent with foreign policy goals. Three equilibria might occur for various parameters of the simple model economy we formulate to analyze the effectiveness of this policy, but in only the first equilibrium does counterfeiting continue at its initial, high level.

In a second equilibrium, both genuine and counterfeit old-style money go out of circulation immediately when new-style money is introduced. This is an equilibrium outcome essentially because of self-fulfilling expectations. That is, fiat money is only accepted if it will subsequently be accepted by someone else.[9]

But again, the abrupt transition that would occur in this second equilibrium might well be a problem for some foreign economies where U.S. currency is widely used. From this perspective, the existence of a third equilibrium—one in which both genuine and counterfeit old-style money disappear gradually from circulation—is especially significant. In this equilibrium, counterfeiting eventually stops because it is unprofitable, despite the willingness of traders to accept counterfeit.

A noteworthy feature of the third equilibrium is that counterfeiting may not stop immediately after the introduction of new-style money, even though it does stop at some later time. In view of this possibility, current U.S. policy should not be judged a failure too quickly if its initial results are not dramatic.

The third equilibrium involves an enforcement effort against counterfeiting in an essential way. In the face of sufficiently aggressive enforcement, counterfeiting would stop even if new-style money were not introduced. The relevance of introducing new-style money is that it reduces the level of enforcement required for success.

[*]The authors are also Adjunct Professors of Economics, University of Minnesota.

[1]Old-style bills are being replaced by new-style bills as they come into the Federal Reserve Banks for processing, but no deadline for turning in old-style bills is being imposed. Since between 50 and 70 percent of the U.S. currency stock is held abroad, partly as a long-term store of value rather than as a medium of exchange, some old-style bills are likely to be outstanding for a long time. (The estimate of 50–70 percent is from Porter and Judson 1996.)

[2]For the equilibrium in which counterfeiting stops immediately, see Proposition 3 (specifically, the discussion of the case when the value of parameter λ_{01} is zero) in Green and Weber 1996.

[3]The other necessary conditions are not as interesting, because they concern things that we assume to be outside the control of the government at the initial date.

[4]Numerous news reports, such as a July 15, 1995, *Los Angeles Times* article, suggest that the proportion is at least this high.

[5]Our analysis of a random matching model follows Kiyotaki and Wright's (1989) in its main respects. Kultti (1996) uses such a model independently to address counterfeiting questions. Our model includes government agents, which are introduced by Aiyagari, Wallace, and Wright (1995).

[6]This is a highly stylized assumption. One might try to motivate it by the idea that a basic commodity such as food both is enjoyed in its own right and is necessary for a person to be productive. However, this and several other highly stylized assumptions are clearly hard to view as photographic representations of an actual economy. Rather, one should think of this sort of model as a kind of science fiction world that shares some salient features with the actual economy and that is simple enough so that the logic of its equilibrium can be understood explicitly.

[7]News reports to this effect were prominent during the months preceding the introduction of the new U.S. $100 bill. Representative accounts are Ghattas 1995 and Specter 1995. A report issued this year by the U.S. General Accounting Office (U.S. Congress 1996, pp. 10, 14) confirms that "Recently, very sophisticated counterfeiters have been producing very high-quality notes . . . [that] are difficult for the public to discern . . . . [M]any foreign law enforcement and financial organization officials had inconsistent and incomplete information on how to detect the Superdollar [a particularly high-quality counterfeit produced abroad]. Thus, financial institutions abroad may be recirculating the Superdollars."

[8]In random matching models of money, an equilibrium always exists in which one or more monies are not acceptable in trade. Here we are asserting something stronger than that. Not only is there some equilibrium where old-style money is not acceptable in trade, but when condition (3) is not satisfied, all equilibria are characterized by the nonacceptability of old-style money in trade.

[9]Self-fulfilling expectations also make it an equilibrium in this model for new-style money not to be acceptable in trade. We ignore this equilibrium because it is so counterintuitive. Li and Wright (1996) show how the model could be modified in agreeable ways that would get rid of the equilibrium.

References

Aiyagari, S. Rao; Wallace, Neil; and Wright, Randall. 1995. Coexistence of money and interest-bearing securities. Research Department Working Paper 550. Federal Reserve Bank of Minneapolis.

Ghattas, Sam F. 1995. Lebanon seen as major outpost for counterfeiters. Associated Press. December 1.

Green, Edward J., and Weber, Warren E. 1996. Will the new $100 bill decrease counterfeiting? Technical appendix. Research Department Working Paper 571. Federal Reserve Bank of Minneapolis. Also available at http://woodrow.mpls.frb.fed.us and http://econwpa.wustl.edu.

Kiyotaki, Nobuhiro, and Wright, Randall. 1989. On money as a medium of exchange. *Journal of Political Economy* 97 (August): 927–54.

Kultti, Klaus. 1996. A monetary economy with counterfeiting. *Journal of Economics* (*Zeitschrift für Nationalökonomie*) 63 (2): 175–86.

Li, Yiting, and Wright, Randall. 1996. Policy analysis in search-based models of money. Manuscript. University of Pennsylvania.

Los Angeles Times. 1995. New U.S. $100 bill sends fear through Russia. July 15: 2A.

Porter, Richard D., and Judson, Ruth A. 1996. The location of U.S. currency: How much is abroad? Manuscript. Board of Governors of the Federal Reserve System. Forthcoming in *Federal Reserve Bulletin*, October 1996.

Specter, Michael. 1995. Forget the rubles! Russians obsessed with U.S. $100 bills. *New York Times.* November 4: 1.

U.S. Congress. 1996. Counterfeit U.S. currency abroad: Issues and U.S. deterrence efforts. Report GAO/GGD-96-11. Washington, D.C.: U.S. General Accounting Office.

Charts 1–4

Elimination of Counterfeiting Over Time

Four Features of a Simulation Over 550 Periods

Chart 1 Probability of Accepting Old-Style Money

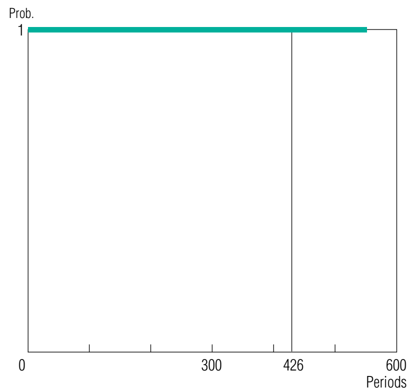

Chart 2 Probability of Replacing Confiscated Counterfeit

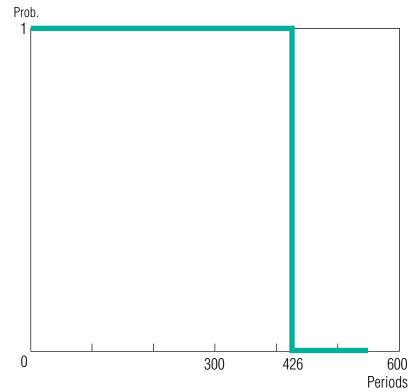

Chart 3 Stock of Counterfeit

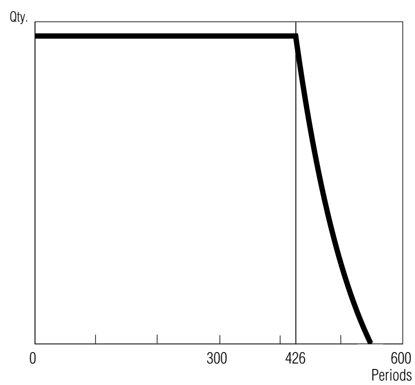

Chart 4 Utility of Participation for Traders