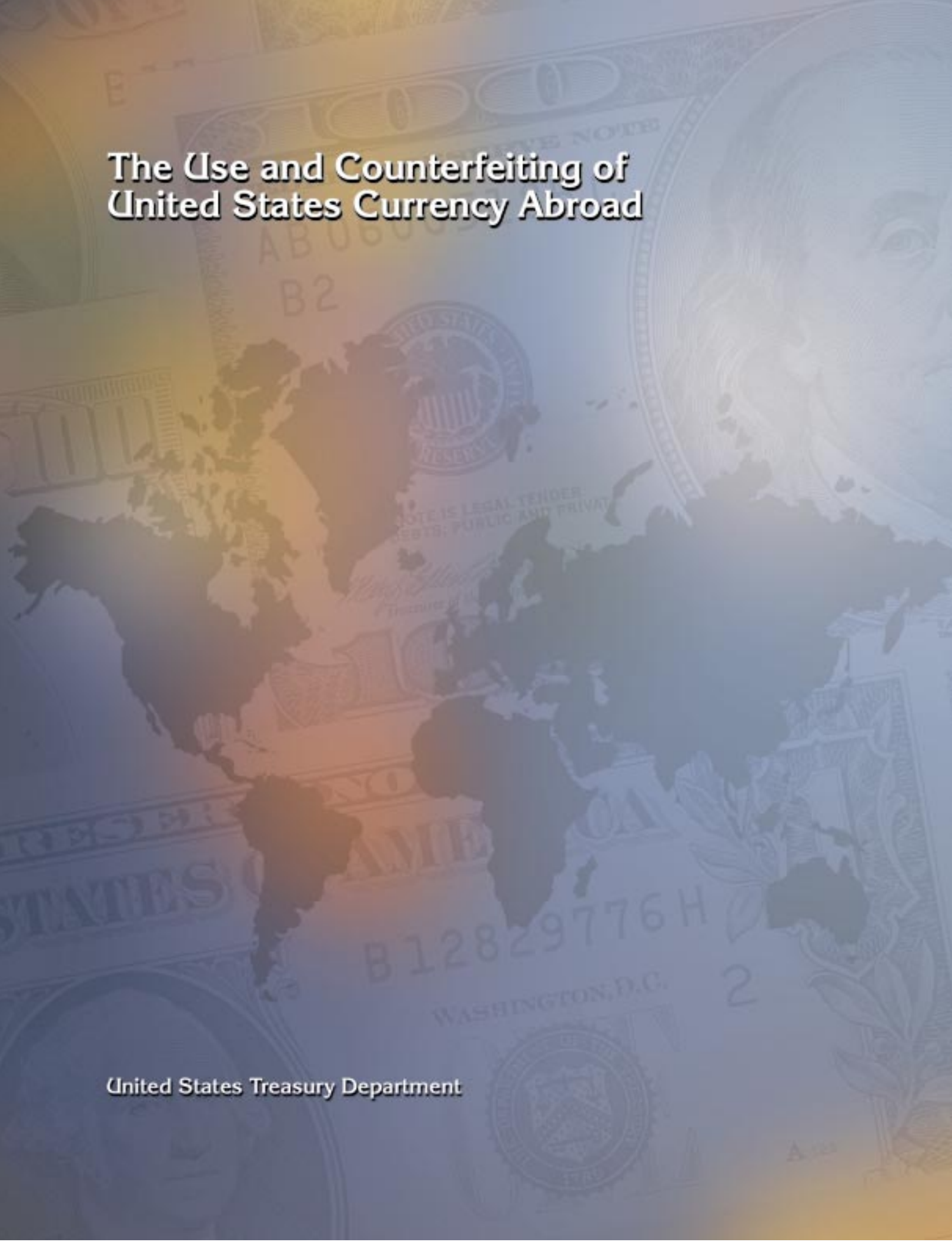
The Use and Counterfeiting of United States Currency Abroad



United States Treasury Department

The Use and Counterfeiting of United States Currency Abroad

A report to the Congress by the Secretary of the Treasury, in consultation with the Advanced Counterfeit Deterrence Steering Committee, pursuant to section 807 of PL 104-132

January 2000

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Preface

For much of this century, United States currency has been used outside of this country as a store of value and a medium of exchange by people facing economic and political uncertainty. Estimates for as far back as 1960 have indicated that half of all U.S. currency in circulation might be held abroad. That proportion has grown over much of the past four decades and began to accelerate during the 1980s. Today, we estimate that as much as 70 percent of all Federal Reserve notes in circulation, perhaps $250 to $350 billion, are now held abroad.

The holding and use of U.S. currency overseas has grown in the wake of high and volatile inflation and economic and political instability in the former Soviet Union and Latin America. In many of these economies, citizens and small businesses continue to face unstable local currencies and underdeveloped banking and payment systems, making it difficult to accumulate savings and make transactions in local currencies. As a result, many residents of transition economies have chosen to carry out critical and large saving and transaction functions in other currencies, including U.S. dollars.

While the billions of dollars held overseas represent a windfall to the U.S. taxpayers in light of the billions of seigniorage revenues that are generated, their presence makes an inviting target for counterfeiters. Counterfeiters range from organized professionals with sophisticated printing facilities to casual amateurs using copying machines or inexpensive computer printers. Counterfeiting is primarily carried out for economic gain but may also be associated with other crimes, including drug trafficking, illicit arms dealing and other terrorist or organized crime operations.

This study reaches three major conclusions about counterfeiting, for which the U.S. Secret Service has had enforcement responsibilities since 1865. First, the problem is somewhat more prevalent outside of the United States than it is inside (although the levels are generally very low). Second, overseas banks and law enforcement agencies are eager to develop expertise, technology, and communication links with the Secret Service to detect and suppress counterfeiting activity. Third, foreign financial and law enforcement organizations generally welcome increased Secret Service presence overseas to coordinate and lead their efforts to detect and suppress counterfeiting activities in their respective countries.

This study was designed to be as comprehensive as possible and to incorporate all available data in the charts, tables, and analyses. In some cases, information could only be obtained in discussions with various governmental and commercial sector officials; data gathered in such a way is inherently fragmentary. It should be noted, however, that the models presented in this report used to estimate the share of currency held overseas and the quantity of counterfeits in circulation generate results that are consistent with the information provided by the teams' interlocutors.

This report was jointly drafted by the staff at the U.S. Treasury Departmental Offices, the U.S. Secret Service, and the Federal Reserve System for the Secretary of the Treasury. The agencies represent an interagency group, the Advanced Counterfeit Deterrence Steering Committee, which consists of staff from the Treasury Departmental Offices, the U.S. Secret Service, the Bureau of Engraving and Printing, and the Board of Governors of the Federal Reserve System. Contributing to this report were Ira Polikoff, Project Director for the International Currency Awareness Program, U.S. Department of the Treasury; James Todak, Special Assistant to the Special Agent in Charge of the Counterfeit Division, and Kevin Rogers, Special Agent assigned to the Counterfeit Division, U.S. Secret Service; Ruth Judson, Economist, and Richard D. Porter, Deputy Associate Director, Division of Monetary Affairs, Board of Governors of the Federal Reserve System; and Jeffrey Pruiksma, Staff Director for Cash, and Jen Pastorick, Supervisor, Cash Services Staff, Federal Reserve Bank of New York.

Executive Summary

- This study reports the results of an investigation of the use and counterfeiting of U.S. currency abroad. The Treasury and the Federal Reserve conducted the investigation pursuant to section 807 of PL 104-132, the Antiterrorism and Effective Death Penalty Act of 1996. The study extended the work of the International Currency Awareness Program (ICAP), which was developed in part to aid the March 1996 international introduction of the new-design 1996-series $100 note.

- The investigation has established new sources of information on the international use and counterfeiting of U.S. currency. Among these sources are high-level contacts in various foreign banking and law enforcement institutions, which have permitted the Federal Reserve and the Treasury to establish new working relationships and channels for the timely transmission of information.

Findings Regarding Currency Abroad

- Foreigners hold U.S. currency for the same reasons that many once held gold coins: Dollars are a secure store of value when the purchasing power of the domestic currency is uncertain or when other assets lack sufficient anonymity, portability, divisibility, liquidity, or security. As a safe asset in an unpredictable world, dollars often flow into a country to displace part of the domestic currency during periods of economic and political upheaval and then remain there long after the crisis has subsided.

- Estimates by the Federal Reserve suggest that at the end of 1998, 50 percent to 70 percent of the $500 billion in U.S. currency outstanding, or $250 billion to $350 billion, was held outside the United States.

- Because currency can quickly move throughout the world, often without being detected, the determination of its location on any occasion is extraordinarily difficult. Nonetheless, it is clear that the lion’s share of overseas currency is in developing countries. We estimate that about 60 percent of U.S. currency held abroad is distributed about equally among three regions of the world: the Western Hemisphere,

Africa and the Middle East, and Asia. The remaining 40 percent is held in Europe and in the countries of the former Soviet Union and their neighboring trading partners, such as Turkey.

- The circulation of U.S. currency overseas provides benefits to both the United States and the foreign users: U.S. taxpayers gain by effectively receiving an interest-free loan in the amount of currency held overseas. Foreign dollar holders benefit by acquiring an asset that is liquid, secure, and stable in value, characteristics that are often unavailable in their own country's currency during and after periods of turmoil.

The Introduction of the 1996-Series New Currency Design (NCD)

- A new currency design was introduced in 1996, beginning with the $100 denomination. The new design incorporated counterfeit-resistant features that make it easier for dollar users to authenticate the notes without special equipment.

- The incidence of counterfeiting of the new-design notes is dramatically lower than that of the older-design notes: Among the pre-NCD $100s in the first half of 1999, the Federal Reserve Bank of New York detected 166 counterfeits per million notes processed, but among the NCD $100s in that period, it found only 20 counterfeits per million notes processed.

- An education campaign to apprise the international market of the new currency design and the no-recall policy on older-series notes was broadly successful. As a result, 1996-series and pre-1996-series notes are widely accepted in virtually all markets.

Findings Regarding Counterfeiting

- The international popularity of the U.S. dollar has also made it a popular target for counterfeiters. The likelihood that a counterfeit note will be found in a batch of otherwise genuine overseas notes, however, is generally quite small, on the order of 1 or 2 counterfeits in 10,000 notes, about the same ratio as is found inside the United States. Maintaining this advantageous state of affairs requires vigilance.

- Worldwide counterfeit currency detection capabilities appear to be high. The audit teams found that at most of the commercial banks and money exchanges, clerks appeared to be able to detect counterfeit U.S. currency by hand examination of the notes, the most common and effective method. The U.S. Secret Service routinely arranges training programs on the detection of counterfeit currency in regions with significant counterfeiting activity.

- Since its inception in 1865, the Secret Service has been responsible for protecting the integrity of U.S. currency abroad: Whenever a counterfeit note is detected or an arrest made anywhere in the world, the Secret Service must be able to respond immediately to develop investigative leads. Because that response will usually involve cooperative efforts with the overseas law enforcement community, the Secret Service must maintain an adequate international presence if it is to keep the international counterfeiting threat at bay.

- The Secret Service has found that the strategic placement of overseas personnel promotes more aggressive police operations in the field, where agents are able to respond more promptly and consistently. In the longer run, the relationships that develop from such day-to-day interactions encourage the Secret Service's law enforcement counterparts to increase the priority given to the investigation of counterfeiting. In locations where permanent placement is not feasible, the Secret Service deploys task forces to target counterfeiters.

- Substantial pools of counterfeit notes cannot circulate undetected for very long. Extensive data-gathering, discussions with currency dealers, observation of currency in circulation worldwide, and economic analysis all indicate that notes are exchanged sufficiently often that they regularly move through financial institutions and exchange houses, which we found to be generally capable of detecting counterfeits. Moreover, although some currency is held "in mattresses" as a precaution against unforeseen events, at least a small share of these notes is always being moved in and out of general circulation. As a result, notes sampled in cash deposits at Federal Reserve

offices reflect notes that have been in normal circulation along with notes that recently left the "mattress."

Innovations to Combat Counterfeiting

- The Secret Service is piloting a web site that law enforcement agencies and currency handlers can use to report counterfeits. When fully implemented, the web site will provide a mechanism for the Secret Service and the Federal Reserve to track worldwide counterfeiting.
- The Federal Reserve Bank of New York has created a new means of distributing currency overseas, called extended custodial inventories (ECIs). The ECI program also provides an efficient mechanism for the international markets to recirculate fit new-design notes and improves the repatriation rate of the older-design notes.
- As a result of the ICAP trips and the establishment of ECIs in Europe and Asia, it is now possible to determine which cities and countries are the first to receive counterfeits in the wholesale distribution chain. This new intelligence permits the Secret Service to respond more quickly and strategically to emerging threats.

Conclusions and Recommendations

- The audit program of the Treasury and the Federal Reserve has established important new sources of information on the use and circulation of genuine and counterfeit U.S. banknotes abroad. In addition, relationships have been developed with the banknote trading communities and law enforcement agencies that allow the Federal Reserve and the Secret Service to work more effectively in the international arena. The Federal Reserve and the Treasury believe that these benefits will grow as the program continues.
- The Secret Service will continue to draw upon the valuable information arising from the joint audits to evaluate its international strategy.

- The extended custodial inventory program has yielded more up-to-date information on overseas counterfeiting and has encouraged the repatriation of old-design notes. Thus, it should be continued and expanded.

- Given the success of the new-design note in deterring counterfeiting, strategies to accelerate the repatriation of old-design notes should be considered.

- The public education campaign contributed to the smooth reception of the new-design 1996-series notes. In the future, dissemination of information on any new currency design—especially training and educational material for both cash handlers and the general public—should reach the international markets well ahead of the actual notes. For the introduction of the remaining 1996-series denominations ($10s and $5s) in the spring of 2000, the international emphasis should be on regions where these denominations predominate, such as Latin America and the Caribbean.

1 Introduction

This study reports the results of an investigation of currency usage and counterfeiting activities abroad. The study was undertaken by Treasury and Federal Reserve officials pursuant to section 807 of PL 104-132, the Antiterrorism and Effective Death Penalty Act of 1996. The study extended an earlier effort that preceded the introduction of the 1996-series $100 note in March 1996, a project known as the International Currency Awareness Program (ICAP). Through ICAP, the Treasury and the Federal Reserve addressed three issues: Patterns of use and circulation of U.S. currency overseas; counterfeiting of U.S. currency overseas; and appropriate planning for the introduction of the new-design 1996-series $100 note. The successful introduction of the new-design $100 was viewed as extremely important because it represented the first significant redesign of U.S. currency in nearly sixty years.

Indeed, the Treasury and the Federal Reserve recognized that favorable overseas reception of the 1996 note was critical because the majority of $100s in circulation were believed to be held overseas (table 1.1). ICAP activities consisted of study trips to areas of the world where dollars circulate and, later, the establishment of facilities to encourage both recirculation of fit currency and repatriation of old-series currency. On the education side, the trips gathered information on the educational materials that should be distributed abroad and sought to inform market participants about the characteristics of the new notes. Part of the motivation for the educational campaign was to avoid the kind of confusion and panic that struck in Russia when the 1990-series $100 note was introduced. In that case, the U.S. ambassador to Russia had to appear on local television to quash rumors that older-series notes were to be recalled.

1.1 Design of the Audit Plan

The audit plan in this study takes account of all the information and understanding that the Treasury and the Federal Reserve possess concerning overseas counterfeiting and currency holdings. In accordance with the congressional mandate, the study is based on three components: Models of U.S. currency usage overseas, models of counterfeiting

Table 1.1

U.S. Banknotes in Circulation, $100s in Circulation, and $100s Held Overseas

Billions of dollars, except as noted, at year-end

Year	Total (1)	$100s (2)	Share of $100s in total (percent) (3)	$100s held abroad, wholesale (4)	Share of $100s held abroad, wholesale (percent) (5)
1965	38.0	8.1	21.4	3.9	48.3
1970	50.8	12.1	23.8	5.7	47.5
1975	77.6	23.1	29.8	10.0	43.2
1980	124.8	49.3	39.5	23.8	48.4
1985	182.0	81.2	44.6	45.8	56.4
1990	268.2	140.2	52.3	85.7	61.1
1991	288.5	157.2	54.5	101.7	64.3
1992	314.8	177.1	56.3	114.6	64.7
1993	344.5	201.5	58.5	133.5	66.3
1994	382.0	229.1	60.0	156.9	68.5
1995	401.5	241.5	60.2	169.2	70.1
1996	427.1	261.4	61.2	186.6	71.4
1997	458.0	291.6	63.7	211.4	72.5
1998	492.2	320.1	65.0	228.0	71.2

Sources: Columns 1 and 2: Treasury Bulletin, various issues
Column 4: Federal Reserve Board Flow of Funds Accounts (Release Z.1).

abroad, and information obtained from country surveys with cash handlers and others knowledgeable about the extent of currency usage and counterfeiting issues abroad.[1]

The Federal Reserve and the Treasury have information on these subjects from a variety of sources, including U.S. Customs reports, shipments by overseas wholesalers and published proxies for those shipments, estimates based on in-country surveys from dollar–using countries, national surveys of domestic currency holdings, and a variety of empirical models developed by the Federal Reserve that estimate overseas flows or holdings based on realistic assumptions concerning international currency usage. On the

[1] In the early phases of this project, ICAP teams did carefully inspect or "audit" large samples of currency in commercial banks for the presence of counterfeits. However, these "audits" uncovered very few counterfeits, produced no other useful information, were costly to conduct, and were difficult to arrange. As a result, large-scale currency inspections were discontinued, but on an ad hoc basis, the U.S. Secret Service has inspected batches of counterfeits and suspected counterfeits on these overseas trips. From time to time, at the team's request, banks have offered genuine notes for the team's inspection so that the fitness, or condition, of such circulating notes could be directly established; on these occasions, the teams have had another opportunity to look for counterfeits.

counterfeiting side, the U.S. Secret Service collects information from around the world on counterfeits that have been passed or seized and related information from country surveys. In addition, the Federal Reserve collects data on counterfeits found in deposits at Federal Reserve Banks. Finally, using data on cash processing and on notes passed both domestically and internationally, the Federal Reserve has developed models to estimate the quantity of counterfeit currency in circulation.

1.2 International Demand for the U.S. Dollar

Due to its relative stability and near-universal recognition and acceptance, the U.S. dollar functions as both a store of value and a medium of exchange when other stable or convenient assets are not available. Thus, during times of economic or political crisis, cash in a stable and familiar currency such as the dollar is often sought as a portable and liquid hedge against possible devaluation. Similarly, dollars are a popular medium of exchange in regional or cross-border trade when credit markets are undeveloped.

The Federal Reserve supplies currency on demand, so the quantity of currency in circulation increases when new demands originate anywhere in the world.[2] Currency in circulation outside the Federal Reserve and the Treasury was about $500 billion at the end of 1998. Current estimates indicate that the proportion held abroad is about 50 percent to 70 percent of the amount in circulation, or roughly between $250 billion and $350 billion. Most of the currency in circulation is in the form of banknotes. Table 1.1 shows the amount of paper currency in circulation as well as the amount in the largest active denomination, $100s. In value terms, the share of Federal Reserve notes held as $100s has increased from around 21 percent at the end of 1965 to around 65 percent at the end of 1998. In addition, the share of $100 notes estimated to be held outside the

[2] As a share of domestic monetary aggregates in the United States, currency is relatively small: it comprises just over 40 percent of the narrow monetary aggregate M1 and about 10 percent of the broader monetary aggregate M2. However, a large volume of currency is outstanding. Currency in circulation outside banks at the end of 1998 was about $464 billion, or a little under $1,725 for every U.S. resident. Adding vault cash held inside the United States buoys overall currency holdings to around $517. 6 billion or about $1900 per capita. To keep the discussion in the text in round figures, we will use $500 billion as the 1998 end-of-year currency magnitude.

United States has also increased. As shown in the right-hand column of the table, the overseas share of $100s has gradually risen to more than 70 percent at the end of 1998.

The international circulation of U.S. currency in Europe expanded after World War I in the wake of the hyperinflation induced by the obligations arising from the Treaty of Versailles.[3] At that time, U.S. currency was viewed favorably because the United States was still on the gold standard while Great Britain, whose currency was the most important rival to the dollar, remained off the gold standard until May 1925. Other countries, such as Panama, adopted the dollar as their official currency. More recently, dollar usage has expanded largely because of two events: The breakdown of communism in the former Soviet bloc and episodes of high and volatile inflation in Latin America.

The degree of dollarization that develops during a crisis depends on a country's experience with dollars in the past and its economic circumstances. In particular, demand for dollars appears to depend on two factors. First, dollar inflows are generally higher in richer countries, which have the wherewithal to purchase dollars. Second, the degree to which a country becomes dollarized also depends on the level of development of, and the level of confidence in, the domestic banking system. The less confidence people have that the value of their bank holdings in either dollars or local currency will be protected, the more likely they are to want to hold dollars in cash. Similarly, the more developed the banking system, the more likely it is that people will have a wide variety of options for saving their money.

Because many holders of U.S. currency view it as a form of insurance against future crises, they are reluctant to alter their dollar usage patterns even after the immediate crisis is past. Thus, although changing circumstances may occur in both the countries we visited and the ones we have yet to visit, underlying patterns of dollar usage are likely to change only slowly in countries that use dollars. In countries that do not now use dollars to a significant degree, it is difficult to predict if and when a crisis prompting demand for a second currency might develop.

[3] It was around this time that the Federal Reserve began to collect information on overseas currency shipments to and from Europe (Porter and Judson, October 1996, note 9).

1.3 The Difficulty of Measuring the Extent of International Counterfeiting

The dollar's strong international presence and popularity make it an inviting target for counterfeiters: Where genuine dollars circulate and are accepted, counterfeits also have a chance of being accepted. Inside the United States, jurisdiction over counterfeiting cases is held by the Secret Service, which routinely receives information about counterfeiting from the Federal Reserve, commercial banks, and local law enforcement authorities. Outside of the United States, where, of course, it has no jurisdiction, the Secret Service is both more dependent upon, and less connected to, other sources of information. Further, procedures invoked when counterfeit notes are found overseas vary widely. Thus, without ongoing, direct contact with its foreign law-enforcement counterparts, the Secret Service cannot assess the true nature of the counterfeiting threat it faces abroad. Preliminary results from our investigations indicate that Secret Service agents are now notified more promptly about suspected counterfeiting through the information channels that have been developed.

1.4 Organization of the Remainder of the Report

The remainder of the report is organized as follows. First, Chapter 2 reviews the introduction of the 1996-series new currency design (NCD). Chapter 3 discusses the organization of the country trips and highlights of the information on currency usage obtained from them. Chapter 4 presents the estimates of the quantity and location of U.S. currency abroad. Chapter 5 discusses the business side of the international currency operations and the Federal Reserve's role in them. Chapter 6 explains how counterfeiting works and what is known about the geographic distribution of counterfeiting activity abroad. Chapter 7 presents a model and estimates of the overall potential size of international counterfeiting activity. A final chapter provides a brief summary and conclusion.

2 The New Currency Design: Introduction, Distribution, and Results

The introduction of the new-design currency, while not a central responsibility of the ICAP teams, was an important issue during this period. The new currency design (NCD) was developed to counteract several developing problems related to counterfeiting and authentication (determination that a note is not counterfeit). First, unlike other currencies, the pre-1996 dollar designs had few counterfeit-resistant features that could be easily checked by a dollar user. Thus, some dollar users in the international market had a strong preference for uncirculated currency still packaged in the Bureau of Engraving and Printing (BEP) wrappers.[4] While the Federal Reserve Bank of New York could supply brand new currency to overseas users, it is more costly for dollar users to return already-circulated currency and obtain new currency than it would be to simply recirculate currency. Second, the pre-1996 currency design, while easily recognized by users, had been essentially unchanged for six decades and was likely to become vulnerable to increased counterfeiting because of advances in color printing, computer, and electronic copying technology.

2.1 Overview: Goals, Programs, and Results

The goals for the new design covered three broad areas. First, since the redesign was the first major change in U.S. dollar design in decades, a smooth introduction was highly desirable. Second, the addition of counterfeit-resistant features that could be detected with the naked eye was designed to make dollar users more comfortable that they could authenticate their currency. By extension, it was hoped that dollar users would be more willing to accept recirculated currency. Third, the addition of new counterfeit-resistant features was expected to reduce the incidence of counterfeiting.

Two concrete steps were taken to achieve these goals, and the goals were met. First, the U.S. Treasury Department conducted an international education program, which is discussed later in this chapter and which facilitated the goal of a smooth introduction of the new design. Second, the Federal Reserve Bank of New York established a network of

[4] These bundles of new notes are called “cash packs” and contain 1,600 notes.

facilities to hold and redistribute U.S. dollars to the international market; these are discussed in Chapter 5. These facilities, known as Extended Custodial Inventories (ECIs), have aided in the recirculation of fit (already circulated) currency, which has lowered the cost of using dollars for international users. They have aided the introduction of the new-design notes and, when appropriate, the removal of older-design notes from circulation. The third goal, reducing the incidence of counterfeiting, was also met, as indicated in table 2.1, which shows that rates of counterfeiting experienced with the new design through 1998 were less than one tenth of those of the older-series notes. The incidence of counterfeiting of new-design notes is very low, and, as the new-design notes have displaced older-design notes, overall counterfeiting rates declined by more than 25 percent from 1996 to 1999.

Table 2.1
Counterfeits Detected at FRBNY for $100 Notes, Pre-1996 and NCD
Counterfeits per million notes of same type

Year	Total	Pre-1996	NCD
1999 (through June)	43.5	166.1	19.8
1998	58.8	195.2	19.0
1997	66.6	158.0	7.5
1996	60.6	76.6	1.0

Note: The Federal Reserve Bank of New York processes the largest volume of currency and is the only office that provides information on domestic and foreign currency receipts separately.

The remainder of this chapter reviews the U.S. Treasury's program to introduce the new-design notes. Additional details on the Extended Custodial Inventory Program and its results are in Chapter 5. Additional details about counterfeiting and the Secret Service's programs to reduce it are in Chapter 6.

2.2 Introducing the New Currency Design

The Department of the Treasury and the Federal Reserve are responsible for producing and distributing currency, and also for informing dollar users about design and policy changes related to the dollar.[5] The Treasury, including the BEP and the Secret

[5] The Treasury produces currency and is responsible for currency design. The Federal Reserve is the Treasury's agent for currency distribution.

Service, developed and conducted an education program with the help of the Federal Reserve System, the State Department, and the U.S. Information Agency.

2.2.1 Potential Problems

The transition to the new series had the potential to be difficult for different reasons in the domestic and international arenas. In the United States, it was possible that citizens would be dissatisfied with the new design or even reject the note. In addition, since counterfeiting is not a large concern domestically, it was possible that the expense of the redesign would have been considered inappropriate. In foreign countries, there was the prospect of rejection of the old notes along with uneasiness for the new ones. For example, panic arose in Russia, one of the largest dollar-holding countries in the world in the early 1990s, when new notes incorporating the security thread arrived. This is a country that is hardly unique in its desire for U.S. currency, its preference for the crisp new bills, or its recent experience with currency "reforms." As late as 1993, a currency reform there left many people with worthless rubles and bitter memories. Thus, it was deemed crucial to reassure citizens of the former Soviet Union and other countries, some of them heavily dollarized, about U.S. plans for a smooth transition to the new currency design.

2.2.2 Objectives

Because of the concerns mentioned above, and because the redesign was the first major change in U.S. currency in many decades, an effective public education campaign was essential. The purpose of the campaign was to inform users of U.S. currency about changes in design and to facilitate a smooth transition to the redesigned currency. The public education campaign had four main objectives: first, promoting acceptance of the redesigned currency; second, explaining the reasons for the redesign; third, familiarizing cash handlers and users with the new features of the redesigned currency; and fourth, assuring foreign users that there would be adequate supplies of the redesigned currency.

The messages communicated through this program had four key elements. First, U.S. currency will continue to be easily recognizable as "American," with notes remaining the same size and color and retaining basically the same portraits and

vignettes. Second, the redesign maintains the security of the currency by staying ahead of advances in technology. Third, all existing U.S. currency in circulation will remain valid. The United States has never recalled its currency and will not do so now. Fourth, U.S. currency will not be devalued. The latter two messages were extremely significant in certain overseas markets for two reasons. First, virtually all other countries do eventually recall older-design notes when new notes are introduced. Second, in many countries where dollars are heavily used, the general public has had unpleasant experiences with recalls, devaluations, or demonetizations of their local currencies.

2.2.3 Communications Media

In order for the program to work, information had to be transmitted accurately and in a timely manner. To this end, the Treasury developed a Public Education Resource Kit (PERK) and established a Global Information Center (GIC). The PERK was designed to allow individuals to conduct educational programs effectively and independently. The PERK materials included frequently asked questions and fact sheets, posters and brochures illustrating the location of new security features on the notes, and press releases, video, and Internet materials. The brochures were translated into fifteen languages. The GIC's responsibility was to gather, write, and disseminate accurate, timely news stories, and provide interview opportunities concerning the redesign of U.S. currency to worldwide media outlets. GIC was headquartered in the United States and was supported by a network of correspondents in five key regions: Latin America, Western Europe, Central Europe, the Middle East, and Asia/Pacific. The correspondents were responsible for local translations and dissemination of centrally-created material, and, in turn, relayed local perspectives and ideas back to GIC headquarters.

Based on lessons learned during the initial redesign of 1990-series notes, two new information channels were employed. First, U.S. embassies provided notification to various outlets of the 1996-series redesign prior to the first major announcement. Second, national central banks were contacted directly in sensitive countries such as those in the former Soviet Union.

2.2.4 Target Audiences

2.2.4.1 Domestic Audiences

Domestically, the public education campaign focused on several diverse groups simultaneously. Messages were directed toward the general public, the news media and various constituency organizations such as the American Bankers Association, the National Retail Federation, the American Association of Retired Persons, and the National Association of Chain Drug Stores.

2.2.4.2 International Audiences

Internationally, countries were assigned to one of three public-education "maintenance" levels—low, medium, or high—according to their prospective receptivity to the new design. The education initiatives in any one country were then designed according to its assigned level of maintenance.

It was expected that countries in the low-maintenance group would be generally unaffected by the design change because of either low dollar usage or general receptivity on the part of the public, news media, and financial institutions. In these countries, the Treasury planned for a relatively low level of individual attention; however, mechanisms were put in place to respond to inquiries from various groups as well as to provide individuals who could conduct presentations on an ad hoc basis. Countries such as Japan, France, and Great Britain fell within this grouping.

In countries within the medium-maintenance group, commercial organizations and the public would be comfortable with the changes to the currency, but the situation might nonetheless have been fluid. In these countries, attention was paid to basic media outreach and to opportunities for coverage to allay potential fears and possible concerns. Specific activities included providing spokespersons with regular updates on new developments and/or issues affecting the new currency. Countries in this category included Latin American and Caribbean nations.

The high-maintenance group included countries where one or more of the following characteristics could be found: high usage of U.S. currency, public disapproval of the currency change, or inaccurate media coverage. In these countries, considerable

weight was put on the reason for the change, namely to create more secure notes that would be more difficult to counterfeit, and the public was assured that older-series notes would not be recalled. The same procedures for media contacts were used in the medium- and high-maintenance countries. In addition, "third-party contacts" were instrumental in effectively augmenting the public education program in the high-maintenance countries. These contacts were individuals or organizations that were credible opinion makers, able to straightforwardly make the case that the United States was making an improvement to its currency that would benefit all who wished to use it. This category included Russia, some countries in eastern Europe, and much of the Middle East.

Obtaining the assistance of third-party contacts was central to the Treasury's strategy in the former Soviet Union. Having such endorsers added flexibility but also carried the risk of miscommunication. On balance, though, the advantages dominated and fell into three main categories. First, contacts could play roles that would be inappropriate for the U.S. Government. For example, contacts could praise (and implicitly recommend) a currency exchanger who offered a reasonable transaction fee. Second, local contacts could add the weight of inherent credibility to U.S. messages. Third, local contacts could perform other useful functions in reaching target audiences, such as distributing materials, offering training and education, and responding to the public's complaints or questions.

The national central banks in Russia, Ukraine, and Kazakhstan were particularly helpful. For instance, the Central Bank of Russia not only distributed hundreds of thousands of pamphlets and posters and hundreds of video tapes through its regional branches but also conducted training sessions, issued press statements, met weekly with U.S. Government representatives, and allowed its endorsement to appear in U.S. advertising in Russia. Further, the Russian central bank worked with a number of commercial banks to obtain an agreement that limited transaction fees on currency exchanges.

Finally, in these "high-maintenance" markets, especially in the former Soviet Union, experience indicated that news often traveled slowly from region to region. Thus, regional information channels were employed where possible, and care was taken to

make the printed materials plentiful, clear, and easy for banks, exchange houses, and law enforcement personnel to use.

2.2.5 Campaign Effectiveness

There were no major problems surrounding the introduction of the new currency, and in general the program and the materials were well received. Indeed, the Central Bank in Paraguay used the U.S. brochures as a model for the introduction of their newly designed 50,000 guarani note.

There were two types of comments that suggested slight changes for future currency design introductions. First, some banks indicated that the elapsed time between the unveiling of the new note and its issue date was insufficient. Some banks and exchange houses, particularly in Latin America and the Caribbean, did not receive the relevant information until after the introduction of the new notes. In the future, distribution plans for educational materials will take more careful account of the time required for both shipping and distribution of these materials to various regions in the world. The same institutions, especially the U.S. Information Agency and the U.S. embassies and consulates, will continue to be used to distribute educational materials abroad.

Second, some cash handlers requested specific training on the NCD notes. Both cash handlers and law enforcement officials in the Dominican Republic expressed interest in training on the technical features, including the security thread, the optically variable ink (OVI), and the micro printing. In both instances, the Secret Service special agent assigned to the team made arrangements to provide the assistance requested. Future educational efforts will include additional technical advice.

As of December 31, 1998, the proportion of NCD notes in the stock of circulating $100 and $50 notes was 66 percent and 49 percent, respectively.[6] These figures would tend to indicate that a slow but steady transition is occurring and that our rollout strategy has not been overly aggressive. However, it would be helpful to revise the message a bit to advance the repatriation of older-series notes. To this end, a clear statement should be

[6] At this time, the NCD $100 had been in circulation for about twice as long as the NCD $50.

prepared to explain that while older-series notes are still legal tender, the security features of the new-series notes provide more protection against counterfeiting.

2.3 Perception of the New Currency Design

Without exception, financial institutions and law enforcement organizations welcomed the introduction of the NCD banknotes with the added security features. They were delighted that the United States, like many other countries, will now include watermarks, OVI, and other overt features in the currency. Since most individuals identify counterfeits by examining the feel of the paper and looking at the portrait, they were pleased that the same paper and historical figures were used. Only a few banks were disappointed that the color and size of the notes remained the same, but the issue here is one of ease of denomination identification and not counterfeit protection. The only other comments about the design centered on the location of the portrait. Some felt that moving the portrait to the left rather than the right tended to hamper counterfeit detection since right-handed cashiers hold a stack of notes with their left hand and flip through the notes with the right hand, thus exposing the right side of the notes more thoroughly. Because this is a feature that many tellers focus on, it was felt that the portrait would be better placed on the right. However, this is not a critical flaw for two reasons: First, many tellers use other methods for flipping through notes. Second, many other countries have detailed designs on the left side of their currencies and cashiers have adapted their sorting techniques accordingly. In summary, the overall reaction to the new design was quite positive.

3 Country Surveys of Currency Usage: The ICAP Trips

3.1 Background for the Currency Surveys

The 1996-series $100 note represented the most dramatic design change ever seen in a Federal Reserve note, and some difficulties had followed the foreign introduction of its predecessor, the 1990-series $100 note.[7] Hence, the Treasury and the Federal Reserve sought to plan for a smoother international introduction in 1996. During 1994 and 1995, teams from the Treasury and the Federal Reserve conducted a series of trips abroad with the goal of addressing three questions: First, where and how do U.S. dollars circulate outside the United States? Second, where and how do counterfeits circulate, and how are they detected and handled outside the United States? Third, what should be done to make the introduction of the 1996-series note as smooth and trouble-free as possible?

The teams usually consisted of officials from the Board of Governors of the Federal Reserve System, the Federal Reserve Bank of New York, the Secret Service, and the Treasury. The teams met with officials from U.S. embassies, consulates, and related institutions, officials of the host country finance ministries and central banks, counterfeiting enforcement officials, currency dealers and handlers at banks, currency exchanges, and valuables handling services, and various trade associations representing these groups. In addition, other authorities, organizations, businesses, and individuals were visited as conditions dictated.

In 1994 the teams first visited wholesale banknote distribution centers in Europe and Asia to assess the reception that a newly designed $100 note might receive by the banks and other institutions involved in distributing U.S. currency internationally. Next, the teams visited two countries that were believed to have the largest dollar holdings, Argentina and Russia.[8] Then, in September and October of 1995, a team visited the Middle East, a region that historically has been a significant importer of dollars. The countries visited on this trip were Turkey, Egypt, Bahrain, Saudi Arabia, and United Arab

[7] These notes, issued beginning in August 1991, featured a security thread and microprinting.

[8] As a precursor to the Russian trip, Treasury and Federal Reserve representatives also visited one of the new countries that had been part of the former Soviet Union, Belarus.

Emirates. After the 1996 legislation, Treasury and Federal Reserve officials made three trips to Asia to study dollar usage in eight economies: Cambodia, Hong Kong, Indonesia, Korea, the Philippines, Taiwan, Thailand, and Vietnam.[9] In 1997, Treasury and Federal Reserve officials also conducted a trip to four countries in Eastern Europe that were using dollars in the process of moving from a centralized, Soviet-style organization of their economies to market relationships: Bulgaria, Latvia, Lithuania, and Poland. In 1997 and 1998, two trips were also made to Latin America to inspect six countries that have had varying degrees of dollarization over their history: Brazil, Colombia, the Dominican Republic, Mexico, Panama, and Paraguay. Finally, in 1998 a very brief trip was taken to South Africa, which has become an important source of counterfeits recently.

The ICAP visits have resulted in numerous senior-level banking relationships between Treasury and Federal Reserve officials and commercial bankers, global and regional wholesalers, and valuables handlers. These relationships support the exchange of information, and can be instrumental in formulating responses to various international currency crises.

3.2 Criteria for Country Selection

The teams selected the locations (table 3.1) for visits and follow-up contacts on the basis of business, economic, and security considerations. Specifically, the teams visited places that had large dollar inflows or outflows, and in which dollar activity was otherwise indicated to be significant by Federal Reserve and Secret Service contacts and reports. One exception was Colombia: It was selected because it is a major source for counterfeits that are smuggled to the United States and successfully passed on to the public. In some of these economies, dollars enter the economy only through wholesale transit points; in others, dollars are a multipurpose asset and are used for savings, domestic transactions, and trade with neighboring countries. Many countries fall in between these two extremes.

[9] A few smaller-scale trips piggybacked on other activities of Federal Reserve staff. For example, the Korea trip was initiated when one member of the Board staff was on a consulting mission to the Bank of Korea (BOK); he collected the relevant information as a byproduct of his other consulting activities for the BOK.

Table 3.1
ICAP and Related Currency Trips

Location	Time of visit(s)
Argentina	October 1994
Bahrain	September 1995
Belarus	December 1994
Brazil	May 1997
Bulgaria	November 1997
Cambodia	January 1997
Colombia	October 1998
Dominican Republic	October 1998
Egypt	September 1995
Hong Kong	January 1995, October 1996
Indonesia	January 1997
Korea	July-August 1998
Latvia	November 1997
Lithuania	November 1997
Mexico	December 1996, April 1998
Paraguay	May 1997
Panama	October 1998
Philippines	September 1996
Poland	November 1997
Romania	September 1998
Russia	August 1995, June 1997
Singapore	January 1995, January 1997
South Africa	May 1998
Switzerland	November 1994
Taiwan	September-October 1996
Thailand	January 1997
Turkey	September 1995
United Kingdom	November 1994
Vietnam	October 1996

3.3 Use of U.S. Dollars Abroad: Patterns

The dollar is widely used in many countries as a store of value, a transaction medium, and a unit of account even when it is not the official currency.[10] In countries with underdeveloped banking sectors, cash is used to settle transactions of all

[10] For earlier estimates of the foreign component of currency stocks and flows and related issues, see, for example, Avery, Elliehausen, Kennickell, and Spindt (1987), Blinder (1996), Feige (1996), Frankel (1995), Lindsey (1994-95), Mueller (1994-95), Porter (1993), Porter and Judson (April and October 1996), Obstfeld and Rogoff (1996), Seitz (1995), Sprenkle (1993), and Summer (1990,1994).

magnitudes; in such countries with the additional burden of unstable currencies, U.S. dollars are held in cash as a store of value, used for many transactions, and often are the unit of account, especially for larger transactions. Even in some countries with developed banking sectors and stable currencies, dollars are the preferred currency for travelers, for cross-border trade, for settlement of large cash transactions, and for transactions in the informal or gray sector.

The countries visited by the groups provided examples of the varying conditions in which people choose to use and hold U.S. banknotes. Although the relative importance of each varies with economic and political conditions, we found five basic motivations for holding and using cash dollars. First, in times and places where the political or economic situation is uncertain, dollars are held for security against inflation and general calamity. Second, expatriate workers throughout the world often carry their earnings to their home countries in dollars, and between visits home, some of these workers hold dollars in cash rather than in a bank. Third, travelers to other parts of the world carry dollars because they are easier to exchange than local currencies. Fourth, cross-border trade in many areas is conducted largely in dollars. Fifth, the informal or "off the books" sectors in many economies are highly dollarized.[11]

Although the circumstances in each country are unique, demand for U.S. dollars (or indeed any other currency that circulates widely outside its home country) during a crisis does follow certain patterns.[12] A crisis leading to increased dollar usage typically originates as growing fiscal deficits are eventually financed by rapid money creation, which leads to inflation. Surging prices sharply reduce the purchasing power of the domestic currency and the value of accumulated savings. Monetary and fiscal reforms are proposed or promised, but, if they come at all, their arrival is usually slow and erratic. Inflation is correspondingly erratic, which in turn generates uncertainty about the future

[11] It is often asserted that a major source of demand for cash dollars is the world drug trade. This claim is implausible. A high but plausible estimate of the total value of the worldwide drug trade would be about $500 billion, with the amount in the United States about one-tenth of that. If currency turns over once a week and all stages of the drug trade use dollars, the drug trade would still require only about $10 billion in currency, or about 2 percent of the total quantity now in circulation.

[12] Heymann and Leijonhufvud (1995) discuss the forces affecting currency holdings in countries experiencing high inflation but not hyperinflation. See also Obstfeld and Rogoff (1996), Vegh (1992), Savastano (1996), and Kamin and Ericsson (forthcoming).

purchasing power of both cash and bank holdings denominated in domestic currency. Similarly, high and unstable inflation complicates the calculation and evaluation of any large or long-term financial transactions or investments, such as leases or time deposits.

Residents of countries experiencing these crises naturally seek other, more stable assets, and the dollar is often the most convenient and familiar of the available assets. Similarly, they seek to set prices and conduct financial negotiations in terms that are less likely to be affected by domestic inflation. Thus, as the inflationary process evolves, the first use of the dollar is as the unit of account for large-scale and longer-term transactions in the economy. As "dollarization" spreads, more transactions for large items like cars and real estate are either priced in dollars or conducted in dollars. As the realization that using dollars will prevent further losses spreads across the economy, dollar inflows accelerate. In a simple model of this process, the demand for the foreign currency (dollars) depends on the variability of inflation rates and on the difference between the inflation rates of United States and the developing country. The larger the variability and the difference, the greater will be the demand for dollars.[13]

The degree to which a country becomes dollarized and the degree to which residents prefer cash dollars to dollar-denominated bank accounts depends on confidence in the domestic banking system. Periodic bouts of inflation often wipe out the savings held in domestic currency, which encourages flight to other assets. Interest rate premiums and indexation of accounts for domestic inflation are alternatives to dollarization, but they are only effective when people have confidence that they will provide full protection against inflation. Similarly, allowing dollar-denominated deposits is not always sufficient to eliminate a flight to the cash dollar: The bitter experience of having one's foreign currency account confiscated or devalued even once is enough to keep many people from trusting banks for decades.

A country's demand for cash dollars also depends on its economic circumstances: In order to buy dollars, countries must have something of value to sell. Thus, richer countries or countries with well-developed export sectors are more likely to be able to afford to buy dollars.

[13] See Obstfeld and Rogoff (1996, section 8.3)

Although dollars flow into countries when the domestic currency weakens or political crisis looms, they often remain when the crisis passes. For example, an estimated 50 percent of the currency that flowed into Argentina in the late 1980s, into the Middle East before Operation Desert Storm, and into Taiwan after the 1996 crisis in the straits is still in those areas. Thus, it is reasonable to anticipate that dollars will remain abroad even after local currencies stabilize in parts of Eastern Europe, the former Soviet Union, and Latin America.

3.3.1 Argentina

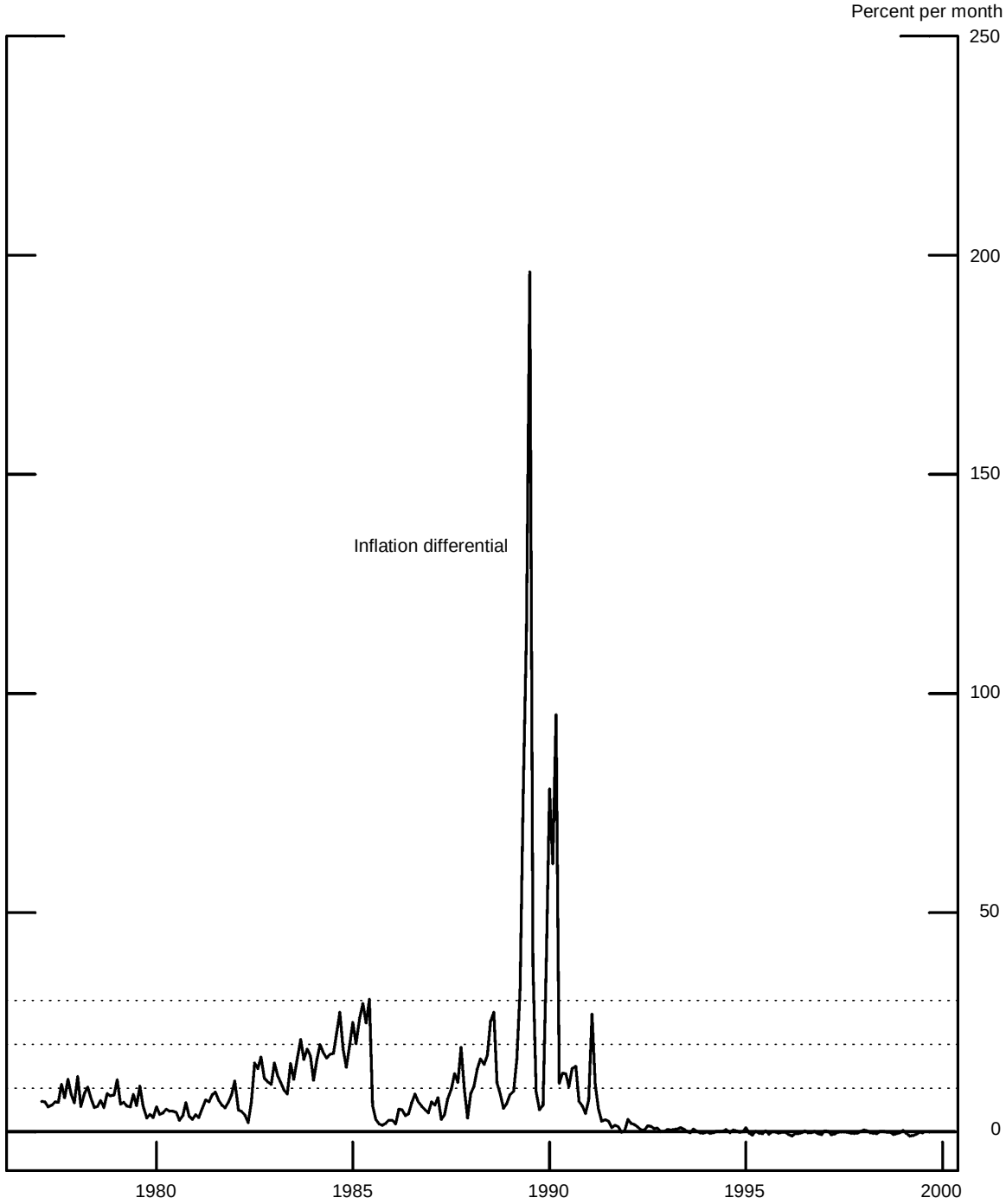
For the past several decades, Argentina has experienced high and chronic inflation. In spite of eight major stabilization plans (an average of two per decade) and countless other attempts at reform, Argentina never managed to reduce its annual inflation to a double-digit rate for more than a year at a time until the 1990s. The surges of hyperinflation in 1975 and in the late 1980s resulted in a persistent "dollarization" of the economy. Beginning in the 1970s, dollars were increasingly used for settling current transactions and as a unit of account. There may have been well over $20 billion in U.S. banknotes in Argentina in the early 1990s and perhaps $25 billion or more now.[14]

The persistent inflation differential between the United States and Argentina resulted in the displacement of the Argentinean currency by the dollar in local portfolios. Figure 3.1 shows that the *monthly* inflation rates in Argentina relative to those in the United States were sizable and often increasing before the 1991 stabilization program. The dotted horizontal lines in the figure mark the relatively rapid differential inflation

[14] Net flows of dollars reported to U.S. Customs on Currency and Monetary Instrument Reports (CMIRs) to Argentina total over $40 billion from 1977 to 1997. Undoubtedly, some of this currency has been repatriated back to the United States after moving from Argentina to neighboring countries and then ultimately back to the states. While these statistics do not capture all of the flows back into the United States, we can use the gross flows to Argentina over this period to make an estimate of the net amount in the country. Currency experts believe that about 40 percent of the gross shipments to Argentina of about $65 billion are likely to remain there. Using this as the basis, the implied amount in Argentina would be around $25 billion from the CMIR statistics. See also Kamin and Ericsson (forthcoming).

Figure 3.1

The Differential between Inflation Rates in Argentina and the United States



rates of 10, 20, and 30 percent per month. The period shown since early 1977 in the figure can be divided into four distinct periods. Inflation averaged around 6½ percent per month until mid-1982, when it began to increase until it reached nearly 30 percent per month in mid-1986. The differential then dropped back before rising still higher in more erratic fashion until it reached nearly 200 percent per month in July 1989, then slowed somewhat but surged once again to nearly 100 percent per month in March 1990. Thereafter, the Argentine government finally adopted reforms that have achieved lasting success.

In April 1991, Argentina embarked on its most successful and ambitious stabilization attempt, pegging their local currency to the dollar at one for one. As can be seen in figure 3.1, the inflation differential after the reform averaged about zero and was much less volatile. The austerity plan was accompanied by an opening of the economy to the rest of the world. Trade reforms resulted in the virtual elimination of quantitative trade restrictions. When the macroeconomic situation stabilized, inhabitants reduced the rate at which they accumulated dollars, but did not immediately convert their stocks of dollars to other assets. Indeed, it appeared that as capital flight was reversed, dollar cash holdings increased to maintain portfolio balance. Moreover, residents continue to settle large transactions in dollars. More recently, as uncertainties have been heightened in a sequence of aftershocks from the Asian crisis, especially after the sharp devaluation of the Brazil *real* in early 1998, Argentine officials announced that the country might give up its own currency entirely and adopt the dollar as its official currency.

3.3.2 The Former Soviet Union

Belarus and Russia have suffered from high inflation, economic instability, an underdeveloped banking sector, a history of confiscation of bank deposits and of unwarranted and inequitable currency recalls, and, until recently, lack of convertibility between local currencies and "hard" currencies such as the dollar. These conditions have contributed to a high level of dollar use in transactions, accounting, and savings.[15] Across Russia, the majority of households hold some dollars, and millions of households

[15] Although the group visited only Belarus and western Russia, patterns of dollar usage are believed to be comparable throughout the former Soviet Union.

use dollars as their chief store of value. The prevalence of dollars, the sophistication of users, and the degree to which news and rumors about dollars spread is quite high in Moscow and a few other financial centers but not elsewhere in Russia. The official attitude toward the prevalence of the dollar in Russia is mixed. Although dollars may be legally held in cash or in bank accounts, the Russian Central Bank supports "de-dollarization," or a return to the ruble.

Interestingly, in the absence of a suitable alternative medium for transactions, dollars were used as a settlement medium within Russia and among countries that were formerly part of the Soviet Union after the collapse of communism but *before* the massive inflation of the 1990s. Though dollars had a substantial foothold in Russia, their usage grew further during the rapid inflation. On average, Russians imported about $2 billion per month in U.S. currency from about 1994 to 1996.[16] More recently, in 1998 and 1999, dollar exports to Russia slowed somewhat, reflecting increased financing difficulties within Russia after the unexpected default on foreign debt obligations in August 1998. The event caused some wholesale currency banks to tighten the terms on which they made short-term credit extensions to Russian banks. In addition, Russia raised the tax on imported foreign currency. However, an important factor restraining currency imports could well have been the softness in the world oil market over the early part of this period, which reduced the resources available for dollar purchases from abroad.

3.3.3 Other Areas

Much of Eastern Europe remains highly dollarized. Dollars were estimated to represent about half of the currency stocks in the two Baltic countries we visited, Latvia and Lithuania. When the currency of Bulgaria, the lev, collapsed in 1996, falling to less than one seventh of its purchasing power in dollars at the beginning of the year, the country imported as much as $50 per person. The fourth country visited, Poland, appears to be less dollarized than the others. But most commentators thought that the informal, or "gray market" sector in this country, as in many other parts of the world, was highly dollarized, although other currencies such as the German mark were also used. Moreover,

[16]Imports of dollars to Russia were probably high prior to 1994, but during the early 1990s, banks reporting their shipments to the Federal Reserve Bank of New York were reporting intermediate destinations (e.g., London or Zurich) rather than final destinations (e.g., Russia).

a substantial part of the economy, ranging from 25 percent to more than 40 percent, was thought to be in this informal sector.

In Western Europe, the banking sector is highly developed, and the domestic currencies are stable. Thus, dollars are rarely used there as a store of value or means of transaction. However, several large wholesalers are based in Western Europe; they supply dollars to, and buy dollars from, correspondents in Eastern Europe, the Middle East, and Africa and sell dollars to customers of their own branches for use in tourism and business in other parts of the world.

Similarly, banks in Hong Kong and Singapore trade dollars with clients for travel and for cash transactions, and they supply a large network of correspondent banks in countries where cash dollars are used heavily, including Burma, Cambodia, China, India, Indonesia, Korea, the Philippines, Taiwan, Thailand, Vietnam, and several East African countries. Dollars are the currency of choice in Cambodia and used to a considerable extent in Vietnam, especially in urban areas. Heightened political tensions between Taiwan and China have led Taiwan residents to import substantial amounts of dollars for use as precautionary savings. There appears to be an active trade in dollars between China and many of its neighbors. In Indonesia, entrepreneurs, who tend to be ethnically distinct immigrants, also hold substantial precautionary amounts of dollars.

All forms of dollar usage are represented in the Middle East. Throughout the region, dollars are the preferred currency for travelers. In the Gulf States, local currencies are stable, so dollars are reserved for cross-border trade and travel. Traders from the rest of the Middle East and the former Soviet Union use dollars for their purchases. Residents carry dollars when traveling outside the region, and expatriate workers carry dollars to their home countries. In Turkey, dollars are used both for trade and travel and for domestic transactions and saving because of persistent high inflation. In Egypt, dollars are used very little except for travel.

Dollar usage has had a long history in Latin America and the Caribbean. Many Latin American countries used dollars exclusively or in large part at one time in their history: Argentina, Uruguay, Cuba, the Dominican Republic, Mexico, Panama, and Peru fall under this heading. Residents of these countries began to use dollars for the same

reasons as in other countries, and the dollar is by far the most familiar of all foreign currencies in Latin America.

3.3.4 Remaining Geographic Uncertainties Regarding Currency Location

Although the teams were not able to visit every country in each region, it was possible to make reasonable educated guesses about dollar usage for several of the unvisited countries by drawing on a variety of economic intelligence and information from various businesses and Secret Service contacts. For example, it seems clear that there are large quantities of dollars circulating in parts of the former Soviet Union that were not visited, such as Estonia, Kazakhstan, and Ukraine, and in parts of Eastern Europe. Similarly, there are strong indications that significant quantities of dollars are used in Peru and Cuba.

In Asia, dollars are used for trade and savings, although gold is also used for savings in both Asia and the Middle East. A substantial quantity of dollars apparently flows into and out of China in connection with trading activity with Hong Kong, Russia, Taiwan, and Vietnam. As for savings, during the 1995 trip to Turkey, the team found that U.S. cash holdings might be as much as $10 billion, but such an amount would be only about one-fifth of Turkish private holdings of gold.[17] It is possible that U.S. banknotes will gain on gold for several reasons. First, dollars are probably more liquid than gold in almost all situations, especially emergencies. Second, gold has been a relatively poor investment over much of this period. Finally, gradual shifts from commodity assets such as gold to financial assets such as dollars and bank accounts are often a normal part of the development process. In any event, information about the behavior of the more than 2 billion people in China and the Indian subcontinent could explain a great deal about the true size of overseas holdings, and future currency trips to these areas will likely provide that information.

[17]Worldwide private gold holdings, which totaled about $670 billion in 1997 in various forms, such as jewelry, religious objects, bars, and coins, are much larger than total overseas U.S. currency holdings.

3.4 Judging the Plausibility of Overseas Dollar Holdings from Country Surveys

The Federal Reserve estimates that approximately one-half to two-thirds of all U.S. currency, or between $250 billion and $350 billion, is held outside the United States.[18] Since each dollar outstanding effectively represents an interest-free loan to the U.S. Treasury, the value of the external dollar circulation in interest costs avoided is on the order of $12 billion to $17 billion per year.[19] As shown in table 1.1 above, the number of dollars in circulation has been increasing steadily since 1980, and a sizable share of this growth can be attributed to overseas demand. The dollar is thus a valuable export whose quality, or integrity, should be protected. As with many products, users have alternatives; in this case, they include the German mark, Japanese yen, Hong Kong dollar, and Singapore dollar.

How plausible are the estimates that $250 billion to $350 billion of U.S. dollars are held overseas? The nature of the aggregate estimate is the subject of the next chapter. The precise amounts that are held abroad have been the subject of a great deal of speculation for some time: As early as the 1920s, after the hyperinflation in Europe, the Federal Reserve Bank of New York began publishing estimates of currency flows to Europe.

Table 3.2 presents some preliminary results from the various Treasury and Federal Reserve surveys. As expected, the per capita estimates tend to be higher in countries that have experienced high rates of inflation, even when the peak inflation experience occurred much earlier. The estimates suggest that the 1.2 billion residents in the twenty-five countries visited held a little more than $100 on average. Since these countries represent about one-fifth of the world's population and appear to hold nearly

[18] See Porter and Judson (April and October 1996).

[19] Technically, dollars held abroad do not reduce the level of either Treasury borrowing or Treasury interest payments. Rather, by expanding Federal Reserve liabilities (Federal Reserve notes outstanding) and, commensurately, Federal Reserve assets (U.S. government securities), dollars held abroad increase the quantity of Treasury liabilities held by the Federal Reserve and the amount of Treasury interest paid to the Federal Reserve. Since, at the margin, all Federal Reserve earnings are returned to the Treasury, the effect is that the Treasury avoids paying interest on the value of outstanding debt equal to the Federal Reserve notes held outside the country. For example in 1994, the estimated $250 billion of dollars held abroad yielded $13.6 billion (at 5.44 percent); this was 66 percent of the $20.7 billion paid to the Treasury by the Federal Reserve.

Table 3.2
Foreign Holdings of U.S. Currency from Federal Reserve and Treasury Surveys

Economy	Amount of currency (billions of dollars)	Population (millions)	Average recent inflation (percent)	Per capita currency holdings (dollars)	GDP held in the form of U.S. currency (percent)
Argentina	25	35.8	102.4	698	8.1
Belarus	3	10.4	62.6	288	5.8
Brazil	1	164.5	205.5	6	.1
Bulgaria	1	8.3	100.0	120	2.8
Cambodia	2	11.2	5.6	179	25.2
Colombia	2	38.6	23.7	52	
Dominican Republic	1.5	8.0	21.3	188	3.9
Egypt	1	64.8	12.8	15	.4
Hong Kong	2	6.5	3.7	308	1.2
Indonesia	2	209.8	9.2	10	0.3
Korea	15	45.9	6.1	327	2.3
Latvia	.5	2.4	243.6	208	5.5
Lithuania	.5	3.6	136.5	139	3.6
Panama	2.0	2.7	1.0	648	11.1
Mexico	5	97.6	21.2	51	.6
Paraguay	.1	5.6	16.9	18	.6
Philippines	2	76.1	9.6	26	1.0
Poland	1	38.6	39.9	26	.4
Romania	2	38.6	134.8	52	.8
Russia	60	147.3	133.2	407	7.7
Singapore	1	3.4	2.3	294	1.4
Taiwan	1	21.7	3.2	46	.3
Thailand	.25	59.5	5.0	4	.1
Turkey	10	63.5	58.2	157	2.6
Vietnam	3	75.1	66.9	40	2.7
Total	143.9	1,239.5	…	…	…
Average	6.3	49.6	62.7	116	3.3

Note: The source data for the average annual inflation rate is based on monthly IFS data in most cases, and, where possible, ten-year average. In several cases, data were only available for shorter periods.

The remaining data in the table were drawn from the CIA World Factbook web site. For the currency holdings, estimates were provided during the team's visits to each country, and are thus estimates as of the most recent trip to each country. ICAP teams in the Middle East also found that about $15 billion was in the Persian Gulf in Saudi Arabia, Bahrain, the United Arab Emirates, Kuwait, Iran, and Iraq. A similar amount was thought to be in India and Pakistan.

$145 billion in currency, the countries not yet visited might well hold enough dollars to account for overseas holdings in the neighborhood of $250 billion to $350 billion. In particular, table 3.2 does not include estimates for several countries in Latin America and the former USSR with high dollar usage.

Thus, the country trips tend to confirm the relatively large estimates of overseas currency. But one substantial area of uncertainty remains. Domestic survey evidence on

individual holdings of currency in the United States shows only about 10 percent of the total U.S. currency stock as being located inside the United States.[20] If 60 percent or so were held abroad, this leaves 30 percent of the currency stock missing. The true domestic figure is very likely larger than 10 percent, but the possibility of foreign holdings substantially larger than 60 percent cannot be ruled out.

3.5 Changing Conditions in Countries Surveyed

Conditions in some countries have changed significantly since the teams' visits. For example, Hong Kong has reverted to China. Three important countries, Argentina, Brazil, and Russia, have each been affected by recent financial crises, with Russia and Brazil experiencing sharp depreciations of their currencies and Russia defaulting on much of its external debt obligations. The precise patterns of dollar usage may have changed as a result of these events, but many of the general patterns almost surely remain, so the information from the trips is likely to remain generally valid. In addition, the ongoing relationships and visits from residents of these countries provide periodic updates. Several factors could, however, change the demand for dollars. The most obvious of these are increasing use of electronic payments for transactions and the upcoming introduction of euro-denominated banknotes.

3.5.1 Transaction Technologies

As countries develop and stabilize, noncash transactions and savings mechanisms such as checks, credit cards, debit cards, and bank accounts can displace paper currency. However, discussions during the teams' trips indicate that people who have been driven to dollar usage by crisis are often extremely cautious about moving away from the tried-and-true dollar. At the wholesale level, payment systems that displace dollars are embraced when credit systems and contract enforceability are established; these developments occur more readily within countries than across borders.

[20]Both the direct survey evidence on currency usage in the United States (Porter and Judson April 1996) and Sprenkle (1993) argue for small amounts such as this being held within the United States.

3.5.2 Euro Banknote Introduction

The introduction of the euro banknotes in January 2002 may provide an attractive alternative to the dollar for many that seek a second currency.[21] There are three groups of people who now use dollars but might switch to euros at some point. First, residents of the euro area who currently carry dollars when they travel outside their home countries will no longer need dollars within the euro area and may be able to exchange euros just as easily and cheaply as dollars outside this area if the euro succeeds as an international currency.[22] These users might well switch to euros fairly quickly. Second, dollar users in countries close to the euro area may find that euros are just as convenient, and, in some cases, more convenient, than dollars. However, these users might need somewhat more time to become accustomed to euros, and thus might not generate large movements to euros and away from dollars for several years. Third, although residents of countries experiencing political or economic crisis might in the long run prefer to hold euros, second-currency-holding habits change only very slowly. Thus, this group of dollar users is also unlikely to switch away from dollars very soon, if ever. Overall, current users of dollars as a store of wealth will likely be cautious about switching to euros until the euro becomes somewhat more established.

[21]The euro was introduced as a unit of account for most members of the European Union at the beginning of 1999. Euro banknotes will not be issued until 2002.

[22] Among other factors, the cost of exchanging money is a function of the volume exchanged in a particular currency and location. Dollars are relatively cheap to exchange in many places because they are heavily used.

4 Models of Overseas Currency Demand and Usage

The Federal Reserve has developed several statistical models for estimating stocks and flows of U.S. dollars abroad.[23] The models indicate that between 50 percent and 70 percent of U.S. currency is now held outside the United States and that the growth in currency in circulation over much of the 1990s has been driven mostly by overseas demand. These models use confidential data on currency shipments to and from the Federal Reserve Bank of New York, data collected by the U.S. Customs Service through their Currency and Monetary Instrument Report, data on cash processing at Federal Reserve Banks, and less formal information collected during the study trips.

4.1 Data Sources

4.1.1 Major Wholesale Dealers of Banknotes

Currently, monthly reports on the volumes, sources, and destinations of incoming and outgoing international currency shipments are provided to the Federal Reserve Bank of New York by large commercial banks and other banknote brokers. These reports have been provided since 1988, and were also provided for a period between World War I and World War II.

About $150 billion in U.S. currency on net moved overseas via wholesale banknote brokers in the eleven years from 1988 through 1998. Before 1992, the bulk of the net value went to Latin America, primarily Argentina, which received a little more than one-third of total net shipments from the United States to the rest of the world in the 1988–91 period. Since then, the onset of turbulence in the former Soviet Union has sharply boosted shipments, especially to Russia. Indeed, the shipments have been so large that, for the eleven years as a whole, the broad region of Europe, Russia, and the other countries of the former Soviet Union has come to account for about five-sixths of net U.S. currency shipments abroad. This growth was spectacular in the mid 1990s when

[23] See Porter and Judson (April and October 1996) for a comprehensive treatment of the various indirect models that have been developed to estimate overseas holdings.

annual net flows to Russia from 1994 to 1996 averaged about $20 billion, or well more than half of total net foreign shipments of U.S. currency in that period.

4.1.2 Federal Reserve Cash Processing Data

The most complete source of indirect information on currency flows is data from currency processing performed at the Federal Reserve System's thirty-seven Cash Offices. The Cash Offices record by denomination and, to a limited extent, by series, all currency received, processed, destroyed, and paid out or shipped to other Cash Offices. These data do not differentiate between foreign and domestic flows, but by comparing Cash Office reports on shipments of $100s and $50s with information from other sources, we can enhance our knowledge of stocks and flows abroad. These data are particularly useful in light of other data, which indicate that the vast majority of cash activity at certain Cash Offices is due to foreign demand for U.S. currency.

4.1.3 Currency and Monetary Instrument Reports (CMIRs)

The most obvious direct source of information on currency flows across U.S. borders is the Currency and Monetary Instrument Reports (CMIRs) required by the U.S. Customs Service. In principle, these reports are a rich source of information because individuals and firms making almost any shipment of more than $10,000 in cash across a U.S. border are required to file a CMIR. Nonetheless, at least six factors indicate that CMIRs are neither accurate nor thorough measures of large cash shipments outside the banking sector.

First, because arriving travelers must pass through Customs but departing travelers ordinarily do not, the CMIR data are biased toward measuring inflows of currency. Departing travelers are occasionally informed of the filing requirement or are targeted for enforcement purposes, but their responses are not adjusted statistically to account for the large proportion of outgoing travelers who should, but apparently do not, file CMIRs. For example, in 1994 the number of travelers entering the United States from anywhere in the world was about the same as the number of travelers leaving (about 45

million), but in that year, about 170,000 arriving travelers filed CMIRs, whereas only about 34,000 departing travelers did so.[24]

Second, CMIRs do not capture shipments of $10,000 or less, activity that could cumulate to a significant total. In 1994, excluding travel to Mexico and Canada, 18.7 million U.S. residents left the United States, and 19.2 million visitors entered. If these travelers carried an average of $1,000 each, the unrecorded flows in each direction would be relatively large, about one-half of the $32.8 billion of inflows and $39.1 billion of outflows recorded on the CMIRs. For example, banking statistics seem to indicate that U.S. currency goes only *from* the Caribbean to the United States; the currency going from the United States *to* the Caribbean does not go through the international banking system but in the pockets of American tourists and others, and most of it presumably goes unrecorded. Flows for the neighboring countries, Canada and Mexico, also exhibit the bias of one-way measurement: CMIRs record currency moving within the banking system from Mexico to the United States, and from the United States to Canada, but mostly not in the opposite directions. In all likelihood the net flows between the United States and its neighbors in most time periods are relatively small.

Third, many shipments greater than $10,000 are likely to be misreported or not reported at all. Although banks and other firms are accustomed to filing CMIRs and probably do so fairly diligently, individuals are potentially less aware of these reports, less willing to file them, or even eager to avoid them.

Fourth, the record-keeping system for CMIRs was designed to identify individual transactions, not to develop accurate aggregate statistics on currency flows.

Fifth, the 1996 establishment of the extended custodial inventory (ECI) facilities (see chapter 5) has distorted the information available from the CMIRs in two ways relative to that available from wholesale sources: (1) The CMIRs do not record the ultimate destination or origin of the currency being shipped, whereas the Federal Reserve Bank of New York does, at least in principle.[25] (2) The complete set of Federal Reserve

[24]Most likely as a result of this one-sided recording capability, net shipments of U.S. currency in the CMIR statistics totaled only $340 million in the period from 1977 to 1996, a period over which all other estimates of such flows increased by several orders of magnitude more.

[25]On shipments to the United States, the Bank attempts to determine the city in which the wholesale bank first assembled the currency.

data (cash processing, the money stock, and the New York Reserve Bank confidential data on shipments) capture *all* of the movements in and out of the ECIs, whereas the CMIRs do not.[26]

In sum, CMIRs are an important source of data, but they probably do not provide accurate aggregate data because of a one-sided system for collecting data, the omission of some potentially large volumes of currency flows, and the inability to cope with intermediate ECI transactions.

4.1.4 ICAP Trips and Other Institutional Information

The Federal Reserve estimates also draw on institutional knowledge of several types, most having to do with patterns in the issuance and usage of the $100 note, the largest denomination now issued by the Federal Reserve. Two facts about the use of $100s suggest that the net new demand for them is coming primarily from abroad. First, although $20s are in more common use than $100s in the United States, $100s now make up nearly two-thirds of the dollar value of all U.S. currency outstanding. Second, the Federal Reserve Cash Office for the New York City region, which is the primary supplier of currency to foreign users, makes shipments of $100s that are unusually large relative to its region's share of nationwide vault cash, population, income, and deposits (table 4.1). The New York City Cash Office has accounted for seven-eighths of the net national issuance of $100s from 1974 to 1998. At the same time, survey data on holdings of the $100 bill indicate that U.S. residents hold, on average, less than one-third of a single bill per person, while for every U.S. resident, about twelve $100 notes now circulate somewhere in the world. In sum, the basic information we have from surveys and the Federal Reserve Cash Offices about the circulation of $100 notes is consistent with relatively low dollar use domestically and high use abroad.

[26]The CMIRs capture only the initial and final transactions in the circular flow of currency from and to the United States. The Federal Reserve data capture all intermediate cases when the fit currency returns to the ECI.

Table 4.1
District Shares of Nationwide Characteristics of Economic and Cash Activity

District	Vault cash[1]	Population[2]	Personal income[3]	Savings and transaction deposits[1]	$100s issued[4]	All denomina-tions issued[4]
Boston	6.6	4.5	5.0	4.6	4.1	9.7
New York	10.1	11.4	13.8	12.6	88.2	86.1
Philadelphia	2.3	4.4	4.6	2.2	2.9	-0.7
Cleveland	9.4	6.8	6.4	8.5	4.4	12.9
Richmond	18.2	8.6	8.5	16.9	6.5	9.4
Atlanta	7.8	13.0	11.8	8.5	-14.4	-32.4
Chicago	11.2	10.7	10.9	12.1	13.3	28.2
St. Louis	3.2	3.5	3.3	4.1	3.8	4.1
Minneapolis	3.7	2.0	2.0	4.6	1.7	1.9
Kansas City	3.3	4.9	4.6	4.7	3.2	4.7
Dallas	5.6	8.7	8.0	5.2	0.9	-3.7
San Francisco	18.7	21.6	21.0	15.9	-14.7	-20.2
Total	100.0	100.0	100.0	100.0	100.0	100.0

1. 1998:Q4.

2. 1998.

3. Total personal income in 1998.

4. Value issued from 1974 to 1998 inclusive; authors' calculations.

4.2 Methods for Measuring Flows and Stocks of U.S. Currency Abroad

In terms of the geographic split in holdings, it is unwise to rely exclusively on official data sources because they often miss significant currency flows. For example, between two countries, currency often flows in one direction in the hands of travelers and in the other direction through (recorded) wholesale shipments between banks.

4.2.1 The Seasonal Method

The seasonal method, as well as various other indirect methods discussed in Porter and Judson (April and October 1996), is based on the idea that the usage of U.S. currency abroad differs from its usage in the United States in some measurable respect. The method relies on three assumptions: (1) The seasonal pattern currency demand in the United States is the same as the seasonal pattern observed for demand in Canada, (2) foreign demand for U.S. dollars has no seasonal pattern, and (3) international demand for

Canada's currency is so small that the seasonal pattern of demand for Canadian currency is a domestic phenomenon. Appendix 1.1 provides evidence on the veracity of these assumptions and details about the model.

The seasonal method produces an estimate of the share of currency held abroad that rises steadily from about 42 percent for 1960 to around 70 percent at the end of the 1980s and basically maintains this level over the 1990s (figure 4.1, top panel).[27] The estimated rise in the currency share abroad stems both from the drop in seasonal amplitude within the United States and from an increase in that within Canada. Toward the end of the period the share of currency abroad stabilizes, but the implied flows abroad pick up sharply (figure 4.1, bottom panel) because of the large increase in overall holdings.

4.2.2 The Biometric Method

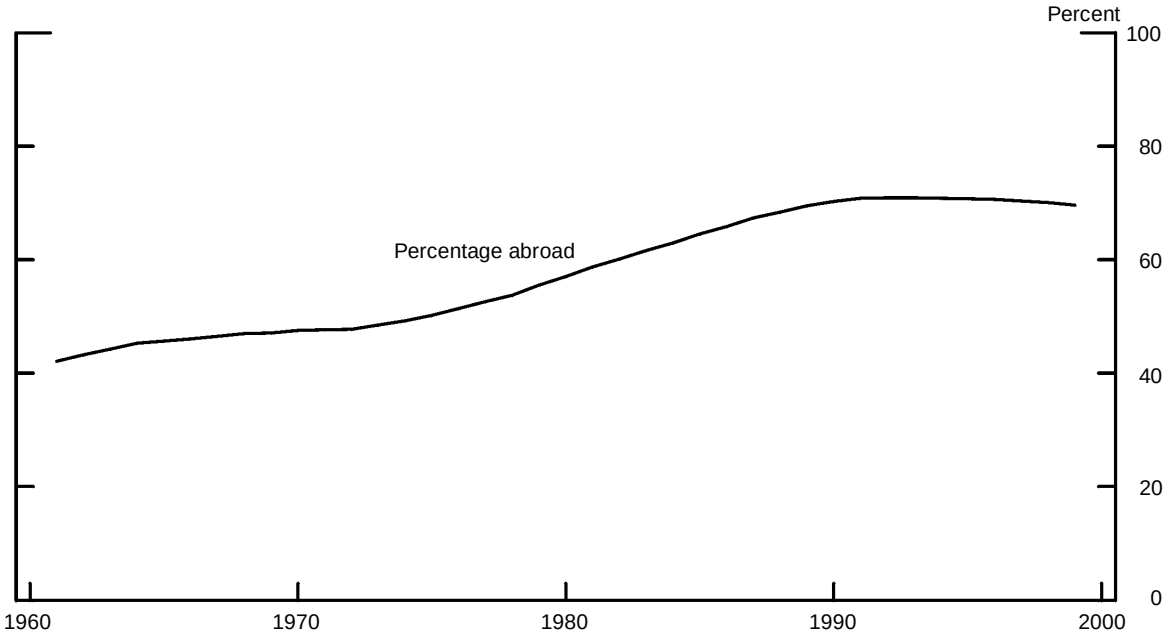
The second estimation method is based on an approach used by biologists to estimate the size of an animal population. Biologists, like bankers, can often only see a small part of the "population" (animals or pieces of currency) at any one time. The approach used by biologists is to capture a sample of the animals, mark them, release them, and capture another sample later.[28] Assuming that the marks do not affect the animals' ability to survive, the share of marked animals in the (unknown) general population will be the same as the share of marked animals in the recaptured sample. For example, suppose that a biologist wants to estimate the number of fish is a pond. The biologist catches 100 fish and marks them. Later, the biologist returns and catches another 100 fish, of which 20 fish have the biologist's mark on them. This would suggest that 20 out of 100 of the total fish population, or 20 percent, are marked. Since the biologist knows that 100 of the fish are marked, the biologist might conclude that 100 is 20 percent of the total population, or that the population is 500. Appendix A.1.2 presents the model in detail.

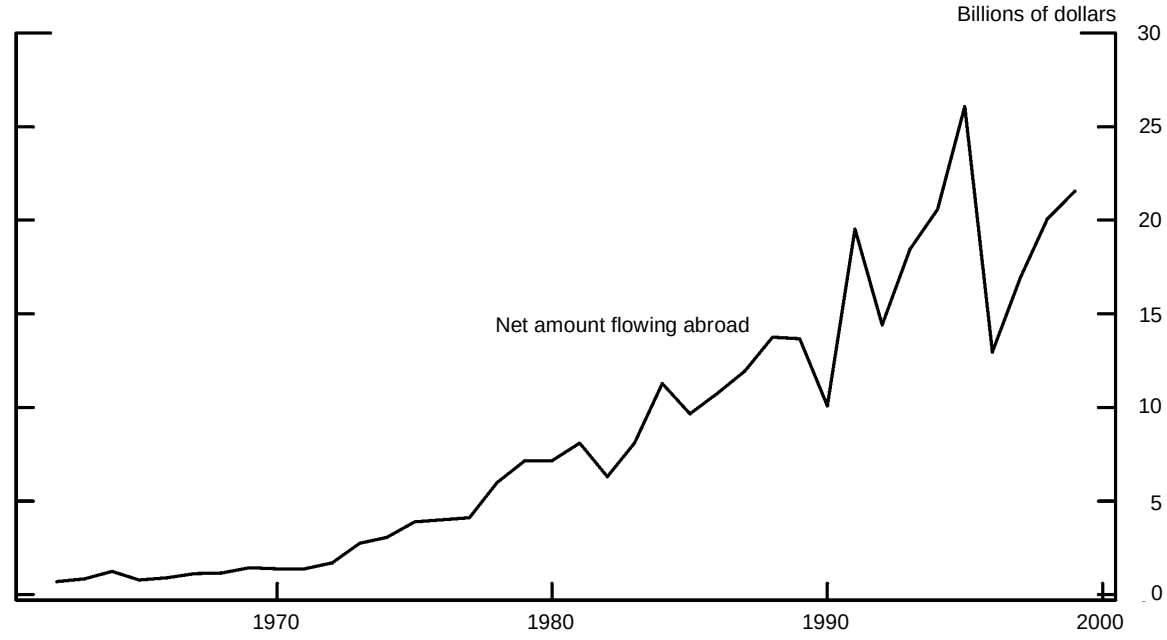
[27]These estimates are based on the banknote denominations common to the two countries, namely the $5, $10, $20, $50, and $100 notes.

[28]This approach draws on studies in the 1890s by a Danish biologist, Carl Petersen.

Figure 4.1

U.S. Currency Abroad, Estimated by the Seasonal Method, Denominations from $5 through $100





This approach can be adapted to measuring U.S. currency abroad by combining two kinds of information: (1) data from Federal Reserve Cash Offices on currency shipped to and from local banks and (2) knowledge that most of the currency shipments handled by the New York City Cash Office are to and from foreign banks. First, data on currency flows at Federal Reserve Cash Offices provide virtually continuous "samples" of currency. Although currency is not literally marked when it is processed at Federal Reserve Banks, statistics for the pre-1990-series $100 note are maintained separately from those for the 1990 and 1996 series. The 1990-series note contains an embedded security thread; the 1996-series note has additional security features, including an enlarged offset portrait, a water mark, and color-shifting ink. The 1990- and 1996-series notes function as the marked animals. For example, when a pre-1996 note is "sampled," or returned to a Federal Reserve Cash Office, it is "marked" by being replaced with a 1996-series note. We know the number of 1996-series notes issued by each Federal Reserve Cash Office, and we know how many return to the Cash Offices in later samples.

Second, we make use of the institutional fact that the cash shipments moving through the New York City Cash Office are mostly to and from foreign banks, and the New York City Cash Office handles most international shipments between commercial banks and the Federal Reserve. Thus, if we can estimate the population of dollars in the area served by each Cash Office, the currency abroad can be estimated as the population in the New York City Cash Office area. Using the biometric method, we find that the December 1998 share of $100s held abroad is around 75 percent. The comparable estimate for $50s is about 53 percent. For lower denominations, insufficient data are available to produce reliable estimates using this method.

4.2.3 Wholesale Demand for Currency

The Flow of Funds Section of the Federal Reserve Board and the Commerce Department's Bureau of Economic Analysis (BEA) jointly publish quarterly estimates of international currency holdings that proxy for wholesale shipments of U.S. currency

(table 1.1, column 4).[29] The published series represents an estimate of wholesale currency shipments that move through the international banking system. Research by Porter and Judson (April 1996) showed that such shipments constitute the vast majority of all international currency shipments, with a relatively minor amount likely being transmitted through the hands of individuals and firms and smaller financial institutions.

The upper panel of figure 4.2 shows the annual changes in the FR-BEA wholesale measure of overseas holdings and changes in the currency component of M1. By construction, the difference between the two series represents the increase in currency held within the United States as well as the net increase abroad that occurs outside wholesale distribution channels. Starting in the 1980s, the peaks and valleys of both series tend to be aligned quite closely, a pattern suggesting that the growth of overall currency in this period has been driven in very large part by movements in the wholesale foreign component. During most periods, the FR-BEA estimate closely tracks (on a dollar-for-dollar basis) the confidential series on wholesale currency shipments collected by the Federal Reserve Bank of New York over the eleven-year period from 1988 to 1998. For example, the lower panel of this figure shows that the series described above in section 4.1.1 predicts the change in the FR-BEA measure extremely accurately, indicating that this proxy is a reliable indicator of wholesale shipments. The alignment of the turning points in the two series, the actual and the predicted, is impressive, suggesting that both tend to capture the same phenomena.[30]

As indicated above, about 90 percent of wholesale shipments are of $100s and the vast majority of these appear to originate and return to just one of the thirty-seven Federal Reserve Cash Offices, the New York City office. Thus, the first working estimate of wholesale currency shipments simply consisted of net shipments of $100s from the New York cash office. Subsequent analysis by the Federal Reserve for the BEA suggested that this choice could be improved by including data from the second most important Cash Office for receiving international shipments, Los Angeles.

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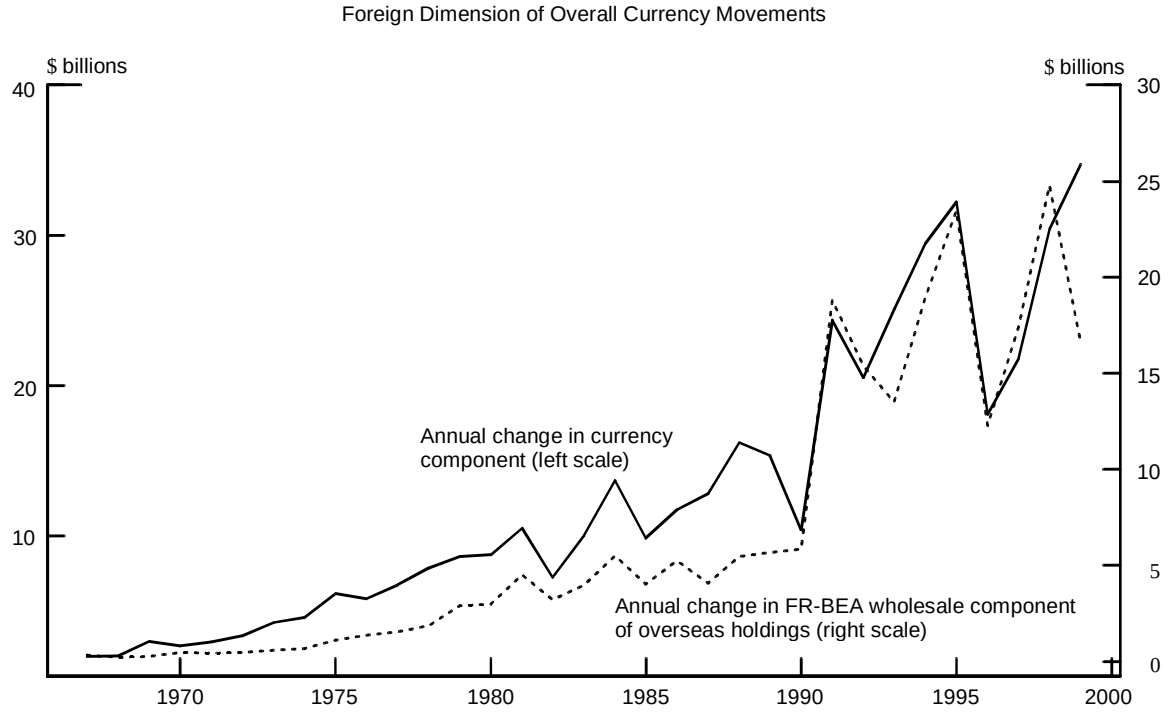
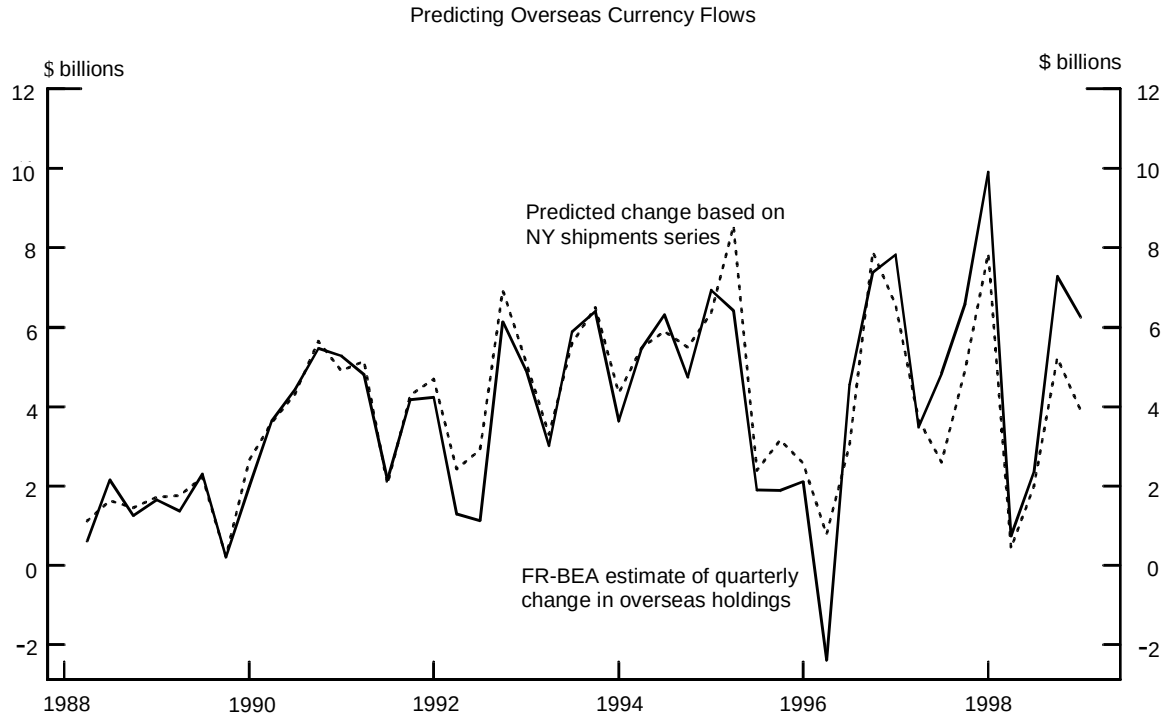
[29]The Federal Reserve began publication in December 1996 and the BEA in July 1997 and in each case both levels and net flows are published. Earlier, the BEA published a similar concept but that series was discontinued in the mid-1950s.

[30]The flows are predicted by the linear regression of net shipments of $100s from the NY and LA cash offices on an intercept and the NY FRB series on net overseas wholesale currency shipments.

Figure 4.2
Changes in Overall Currency and Foreign Holdings





The FR-BEA estimate can be viewed in several different ways. First, as a benchmark for the amount of $100s held overseas in the last few years, this estimate closely matches the other estimates of the percentage of $100s held abroad. The FR-BEA estimate of the share of $100s held outside the United States was 71.2 percent of total $100s in circulation at the end of 1998, which is very close to the estimates for this period obtained from the two methods discussed above, the seasonal (74.7 percent) and the biometric (74.9 percent).[31] Second, apart from these institutional considerations, the FR-BEA estimates can be considered to represent international flows because they also coincide with the outliers from a simple domestic money demand specification. Table 4.1 shows that, from 1974 to 1998 inclusive, the net amount of $100s originating in the Boston Federal Reserve District as a share of all $100s issued was about the same as vault cash, personal income, savings deposits, and transactions deposits at the end of the period: Each component is approximately 5 percent, a figure about equal to the Boston District's share of U.S. population and income. Thus, the amount of $100s in this District appears to be in line with what might be expected from domestic money demand considerations within the District—that is, by and large, the $100s that were issued in this District appear to have been used there.

The same alignment with local demand variables does not hold for three Federal Reserve Districts whose holdings of $100s appear to be disproportionate to the populations they serve within their boundaries: The New York District, which includes the New York City Cash Office; the Atlanta District, which includes the Miami Cash Office; and the San Francisco District, which includes the Los Angeles Cash Office. Over the 25 year period shown in the table, the New York District issued 88.2 percent of all $100s issued but had only 11.4 percent of the population; Atlanta, which had 13 percent of the population, and San Francisco, which had 21.6 percent of the population, each issued negative amounts of $100s on net, 14.4 percent and 14.7 percent respectively.

Issuance in these three Federal Reserve Districts varies markedly from that in the other nine Districts because of the international activity concentrated in three of the

[31] This central tendency, 74.9 percent, for the biometric estimate combines the three methods that appear to be converging at the end of the sample. On the basis of the time series experience with this estimator, we believe that the excluded estimate will also eventually converge to the other estimates, so we choose to discard it from consideration here.

offices: The New York Cash Office, which is best equipped for rapid processing and is located close to major international airports, is the primary dispenser and receiver of international currency for the country as a whole. For shipments from Latin America and Asia via the Miami and Los Angeles airports, the Miami and Los Angeles Cash Offices are primarily receivers of international shipments.

If the population served by each Cash Office is used as the benchmark for the normal level of demand in that region, the two significant outliers are the New York and Los Angeles Cash Offices. That finding was the deciding reason for selecting these two offices in constructing the FR-BEA wholesale estimate. The assumption that all $100s issued by these two offices are sent abroad requires that the quantity of small-denomination notes sent abroad from these two offices as part of wholesale shipments about matches, on net, the $100s used domestically in the regions served by these offices.

Unfortunately, this analysis cannot readily be applied to lower denominations. For denominations lower than $100, notably the $20, which is the next most widely used note, the estimates are far less clear-cut. In part, the variation in the quality of the results for these two denominations represents differences in the way these two notes are used. The $20 is a popular denomination in some developing countries such as Mexico and other nearby Latin American countries, most likely because its purchasing power is convenient for a wide array of transactions. Various indirect methods for estimating overseas holdings suggest that the proportion of $20s held overseas is more than half. But because the $20 seems to be more likely to circulate outside of recorded commercial banking channels, the data on wholesale shipments that allow confirming estimates for the $100 are much less enlightening for the $20, for two reasons. First, $20s are bulkier and hence more expensive to ship than $100s. Indeed, data indicate that, unlike the $100, only a tiny fraction of the $20s that are paid into circulation are shipped overseas. Second, anecdotal information indicates that departing international travelers are far more likely to carry $20s than $100s simply because the $20 is the primary denomination dispensed from ATMs within the United States. In sum, while various indirect methods for estimating overseas currency holdings suggest that more than half of $20s are overseas, the direct evidence is scanty but perhaps suggestive of a much lower figure.

4.2.4 Summary: Reconciling the Estimates from the Various Methods

It is interesting and reassuring to note that these disparate methods yield very similar quantitative results, especially for the key $100 denomination, which accounted for about 65 percent of the total value of U.S. notes at the end of 1998. The biometric method produces an estimate of 75 percent abroad, equivalent to the seasonal method's estimate of 74.7 percent abroad. These two estimates in turn are only a few percentage points higher than the estimate from the wholesale note demand method, which is that 71.2 percent of $100s were abroad at the end of 1998. For $50s, the seasonal method (54.5 percent held abroad) and the biometric method (53.0 percent held abroad) are also in close agreement. It is too early to comment on $20s, as data sufficient to employ the biometric method have yet to become available.

5 The International Distribution of U.S. Banknotes

U.S. banknotes circulate freely throughout the world via bank and nonbank channels. In most periods, a majority of dollars in international commerce move through banking channels, which include local retail banks and major wholesale banknote dealers. Transactions in this channel represent sales and purchases to and from the public and wholesale banks. However, a significant volume of currency also moves across borders outside banking channels, in the pockets and suitcases of travelers and traders. The current audit program and the earlier ICAP efforts were undertaken to further our understanding of these two markets. Unfortunately, no formal data collection system can definitively measure the total dollar value or the location of the U.S. banknotes circulating outside of the United States. In part, this situation arises because currency is one of the most fungible commodities that exists: Countless travelers move significant amounts of currency across various borders without notifying anyone.

5.1 International U.S. Banknote Market Structure

As with other financial instruments, U.S. banknotes are traded internationally with small bid-ask spreads. While many financial institutions trade U.S. dollars for other currencies in the international foreign exchange markets, no more than thirty institutions worldwide participate actively in the wholesale buying and selling (including transport and delivery) of *physical* U.S. banknotes. This group of wholesalers includes those who are active globally and those who trade only in regional markets. Wholesale dealer banks purchase from the Federal Reserve Bank of New York approximately 90 percent of the U.S. dollars that are exported to the international markets. Most of the remaining purchases are distributed among the offices of the Federal Reserve Bank of San Francisco and the offices of the Federal Reserve Bank of Atlanta. The wholesalers purchase banknotes to fill customer orders and the notes are shipped either directly to the customer overseas or to distribution centers. Approximately 75 percent of the dollar value of U.S. notes that the wholesale dealing banks purchase in the markets and return to the United States is deposited for processing at the Federal Reserve Bank of New York; most of the

remaining repatriated notes are deposited at the Federal Reserve Banks of San Francisco, Dallas, and Atlanta.

There are six locations worldwide that serve as the principal international distribution and consolidation hubs for U.S. banknotes: One in the Western Hemisphere (Buenos Aires), three in Western Europe (Frankfurt, London, and Zurich), and two in off-shore Asian centers (Hong Kong and Singapore). Five of these sites have traditionally been extremely active in the U.S. banknote business. Frankfurt became a major U.S. banknote hub as a result of the growth of the Russian markets in this decade. The preeminence of all these locations arises from their accessible transportation networks as well as their historical focus on international commerce.

U.S. banknotes are distributed over international wholesale channels either as new notes (bundled in blue plastic wrappers from the BEP), which is the preferred form for the majority of international market participants, or as fit notes (recirculated banknotes) in good condition. The preference for new notes reflects the associated lower shipping and insurance costs together with the labor costs saved by not having to count and authenticate the new notes. Most importantly, BEP notes are attractive to the international market because their original wrapping and direct delivery from the Federal Reserve Bank of New York assures that they are counterfeit-free.

In view of the disadvantages in handling used currency, not all of the U.S. banknote distributors are willing to deal with second-hand notes. Those that are have created a "redirect market" for them, but even then only the highest quality used notes are deemed acceptable. While not a great deal of information is available about the size or velocity of U.S. banknote transactions in the "redirect" segment of the international market, it appears that the primary economic justification for dealing only with new notes is to avoid the sizable costs incurred in fitness sorting and authentication of used notes. The hesitancy of the banknote dealers to participate in the redirect market also stems from concerns relating to the authentication of the banknotes. This apprehension is especially true in markets such as Russia, where a $100 U.S. note is viewed as a significant amount of money and, therefore, the possession of a counterfeit $100 U.S. note may represent a major potential loss to an individual.

5.2 The Extended Custodial Inventory (ECI) Program

In 1996, the Federal Reserve introduced the Extended Custodial Inventory (ECI) pilot program. It was established in response to the Treasury's introduction of the new-design banknote and recognition that an assured supply of U.S. currency abroad helps to maintain stability in international financial markets throughout the world. The program gave the Treasury an efficient and cost-effective means to distribute the new-design banknotes to international markets and to facilitate the repatriation of old-design currency.

5.2.1 The ECI Pilot Program

The 1996-Series Currency Introduction Plan provided for the establishment of an Extended Custodial Inventory pilot program to facilitate the introduction of the new-design currency, to expedite the repatriation of the old-design banknotes, and to promote the recirculation of fit new-design currency. These objectives were to be accomplished by (1) the strategic stockpiling of new-design notes at ECI sites (two in London and one each in Frankfurt and Zurich), (2) the implementation of sorting requirements for new- versus old-design notes, (3) the deposit of old-design notes at a Federal Reserve facility, and (4) the redistribution of the resulting fit new currency to the international market.

An ECI is an overseas cash depot maintained by a private-sector bank that holds currency for the Federal Reserve Bank of New York on a custodial basis in a segregated area of its vaults. The Federal Reserve Bank of New York manages the ECI program and bears the costs associated with providing management oversight and monitoring the program. It coordinates the shipment and receipt of currency between Federal Reserve facilities and the ECIs. All banknotes, while in inventory at an ECI, and during transit between a Federal Reserve facility and an ECI, are carried on the books of the Federal Reserve Bank of New York.

Each wholesale dealer bank that enters into an ECI arrangement maintains an account at a Federal Reserve Bank. That account is debited whenever the bank sells banknotes and the banknotes are paid out of the ECI inventory to its overseas customers. Conversely, that account is credited when the bank purchases currency from its overseas customers and deposits it into the ECI inventory.

The banks that operate the ECIs must meet the following requirements:

- They must sort the currency they deposit into the ECI inventory into old-design and new-design notes, and then sort the new-design notes into fit and unfit bundles;
- The old-design and unfit notes must be sent back to a designated Federal Reserve cash processing operation for verification and ultimate destruction;
- Fit notes must be placed into the inventory for recirculation; and
- They must report counterfeits detected to either the Secret Service or the appropriate national law enforcement agency.

On balance, participating banks have generated net savings both from the maintenance of ECI inventories on the books of the Federal Reserve Bank of New York and from cost efficiencies that they have gained in transporting currency. Prior to the ECI arrangement, these banks typically shipped currency to customers on a transaction-by-transaction basis. The ECI inventory has enabled them to make larger volume and higher value shipments, thus reducing average shipping costs.

Banks that operate ECI sites bear the costs for insurance coverage that is required and for staffing the ECI site, maintaining processing operations, and making the necessary physical renovations to house the ECI. The banks are contractually obligated to pass along any savings realized from operating ECIs to their customers. Nonetheless, the global wholesale dealers have recognized that the ECI program has become a valuable supplement to the private distribution network.

The pilot program accomplished its primary mission of providing for "orderly markets" during the introduction of the new-design $100 banknote, particularly in the European and former Soviet Union markets, by providing ready supplies of new $100 banknotes. The pilot program was intended to provide an incentive for the major market participants to take an active role in the introduction of the new-design currency and the repatriation of the old-design notes. This incentive would be derived from their on-site control of the inventories that were carried on the books of the FRBNY. Despite additional expenses incurred by the participants, competition increased and pricing

margins substantially narrowed because of the flexibility of controlling the transportation of currency shipments.

Economists at the Federal Reserve evaluated the implicit costs and benefits of the ECI program to the U.S. Treasury and concluded that the implicit cost of the program is small compared with the benefit of potential additional seigniorage that might occur as a result of increased overseas traffic in U.S. currency. The cost is even less significant when viewed in light of continued confidence in the large stock of U.S. currency held abroad. Even though the exact amount cannot easily be determined, it does appear that the ECI program results in a net gain to the U.S. Treasury. Finally, the pilot provided important new knowledge and information on the international flows of U.S. currency, both genuine and counterfeit, which is critical to the Treasury, the Federal Reserve, and the Secret Service.

In summary, the pilot represented a successful new approach in the Federal Reserve System's currency distribution and processing policies. It demonstrated that partnership with the private sector can be a cost-effective and market-sensitive approach.

5.2.2 The Current ECI Program

Based on the experience of the pilot and on market participant comments, a two-part strategy was recommended for the next several years. In January 1998, the pilot was concluded and the ECI program was placed into full operation. Five ECI operations were established in Europe: Two in London, one in Frankfurt, and two in Zurich. These sites serve the European and former Soviet Union markets, which currently hold $100 billion to $140 billion in U.S. currency.

The ECI program has been an efficient vehicle for the international markets to recirculate fit notes and circulate new-design notes while simultaneously expediting the repatriation of older-design notes. Therefore, it was recommended that the ECI program be expanded to serve the Latin American and Asian markets, which currently hold $50 billion to $70 billion each in U.S. banknotes and are projected to be the fastest growing regions for U.S. currency over the next decade. Two ECI operations were implemented in Hong Kong in April 1999. A feasibility study for establishing an ECI operation in Latin America will be explored next.

5.2.3 ECI Accomplishments

The ECI program has facilitated the international distribution of new U.S. banknotes, fostered the repatriation of old-design banknotes, promoted the acceptance of fit (recirculated) new-design banknotes that results in operational savings and is reflected in attractive market rates, and strengthened U.S. information-gathering capabilities on the foreign use of U.S. currency and on the sources of external counterfeiting.

By stockpiling U.S. currency inventories in strategic international distribution centers, banks and currency dealers overseas have an assured, immediate supply of U.S. currency to meet banknote demands and to mitigate financial panics resulting from financial or political disturbances. The ECI inventories also provide an overseas source of U.S. banknotes that is not dependent on transoceanic transportation schedules or subject to adverse weather conditions and time zone differences. The benefits of having ECIs in Europe have been clearly demonstrated over the last two years in serving the volatile banknote markets in Russia, which holds at least $60 billion in U.S. currency. More generally, the ECIs have helped reduce the abrupt fluctuations in market prices for U.S. currency, which frequently resulted from the lag between ordering and delivery of banknotes from New York. In addition, the reporting requirements for the ECIs have increased the stock of knowledge about international currency flows. ECIs are required to report the origin and destination of wholesale currency shipments.

The ECIs in Europe and the Far East can play a significant role in assuaging currency-related Y2K concerns since they can provide ready supplies of U.S. currency to meet any last-minute purchases of currency associated with the century date change and the coming millennium. Arrangements have been made with the institutions that operate the ECIs to increase inventory levels during the year-end period to meet potential increases in demand.

The ECIs have already become an important direct source of information on external counterfeiting in two ways. Prior to ECI operations, limited processing and verification of U.S. banknotes occurred in the international markets, and the majority of the wholesalers' purchases were simply forwarded to the Federal Reserve for deposit and processing. The first improvement is that ECI operators have begun acquiring automated processing and verification equipment and are working with the vendors to improve the

capabilities and sensor technologies that are now available in the commercial markets. These capabilities permit ECI operators to detect the vast majority of counterfeit notes at the point of entry into the wholesale banking stream, and to quickly relay the information to the Secret Service, providing a valuable source of new intelligence about overseas counterfeiting. Since the Secret Service receives information directly from European ECIs, it has developed on-line capabilities to permit external access to the Counterfeit Note Index and also to receive reports of counterfeits detected. The ECIs are among the pilot sites for this new facility. The second improvement is that all notes forwarded to FRBNY are labeled by city and country of origin. Thus, the origin of counterfeits detected in ECI shipments to FRBNY can be determined and is now reported. The European ECIs will soon begin furnishing the FRBNY with city and country-level information for the counterfeits that are detected during verification, which will be incorporated into the database.

In sum, the ECI program has been a success on all fronts: It has raised the efficiency and stability of the U.S. dollar banknote market, it has increased the flow of information about currency shipments, and it has allowed for more timely detection and reporting of counterfeits. It is anticipated that the new ECI locations in Asia and Latin America will provide similar benefits.

6 Global Counterfeiting

Given that so much genuine U.S. currency is overseas, a reasonable question is how much counterfeit U.S. currency might also be circulating overseas? When the ICAP teams were initially assembled in the mid 1990s, numerous reports suggested that vast quantities of counterfeit dollars were circulating overseas. Some of these reports and anecdotes came from commercial establishments seeking to sell their anti counterfeiting products as a method for businesses to protect themselves. Other, more credible organizations stated that vast amounts of counterfeit notes went undetected and remained in the marketplace indefinitely. All such reports and anecdotes have been refuted by the findings of the ICAP trips as well as by data from official sources, an indication that the actual incidence of counterfeiting is relatively low. This chapter examines the economics of counterfeiting, the mechanics of counterfeiting enforcement, the amount of counterfeits that have been passed and seized in various international markets, and the efforts by the Secret Service to respond to various counterfeiting threats. Chapter 6 attempts to place an upper bound on the *quantity of counterfeit currency in circulation* using data collected by the Secret Service and Federal Reserve and an analysis of circulation patterns for genuine and counterfeit currency.

6.1 General Considerations

Counterfeiting outside the United States is lucrative and increasingly easy because of advances in computer technology. Since U.S. dollars are widely held and used in many countries, counterfeiters have many opportunities to pass counterfeit dollars outside the United States. Moreover, the punishment for producing and passing counterfeit dollars outside the United States varies considerably in severity. The level of concern about counterfeiting varied across the countries visited by the teams: Officials and business people in some countries viewed counterfeits as a considerable threat while those in other countries were more blasé, acknowledging that counterfeits are simply part of the banknote business. Regardless of the level of concern, the figures for the incidence of counterfeiting were remarkably consistent: Most banks detect no more than about 1 counterfeit note for every 10,000 notes they handle.

The capability to detect counterfeits is relatively high overseas and, in line with the idea that counterfeits are part of the banknote business, the level of resources expended on their detection is determined in cost-benefit terms. That is, banks displayed varying detection practices depending on local labor costs, local counterfeit activity, and the relative cost of missing a counterfeit. Training tellers to detect counterfeits is not particularly difficult, and it is possible to find and train fully capable tellers even in developing countries. In many countries, tellers have an incentive to detect counterfeits because the value of undetected counterfeits is deducted from their pay. The incentives for shopkeepers are similar: Accepting a counterfeit is likely to result in a direct loss. In countries where dollars are a new asset, small banks might suffer a loss from counterfeiting and then arrange for training to avoid further episodes. Similarly, banks often sort lower-denomination notes only by machine or not at all, reserving the costly but more accurate method of hand counting and verification for the $50 and $100 denominations. In general, counterfeits were typically viewed as an occasional but not serious problem.

In addition to the traditional methods of record keeping, the Secret Service has recently developed two systems to improve statistical reporting: The Counterfeit Contraband System and the new Counterfeit Note Search Site on the Internet. The Counterfeit Contraband System automates the collection of statistical and investigative data regarding counterfeit currency. Information entered into the system is readily available for analysis and is reconciled monthly. The system allows each Secret Service office to see the data of all other offices to determine if and when an investigation moves into another district. Monthly data are closed on the 15th of the following month, allowing the timely use of current statistics.

The Counterfeit Note Search Site on the Internet allows authorized users to specify the identifiers on a note to determine if it is counterfeit. If the note is counterfeit, the classification number is given; if the note is not a known counterfeit, the user is instructed to carefully examine the note for defects and to call the Secret Service office listed on the screen for additional assistance. This site allows the Secret Service to obtain counterfeit information more quickly than in the past. As the system is developed, the Secret Service expects more foreign central banks and law enforcement departments to

use the system, thus incorporating more timely and complete information from a wider array of countries.

Currency sent to Federal Reserve offices is checked for counterfeits, and any counterfeits detected are forwarded to the Secret Service. The counterfeits detected by the Federal Reserve constitute about 20 percent to 25 percent of all passed counterfeits received by the Secret Service. The remaining 75 to 80 percent of counterfeits found are reported to the Secret Service by commercial establishments, financial institutions, and law enforcement authorities.

6.2 Counterfeit Production Methods

There is a wide range of methods for producing counterfeits and a correspondingly wide range of required inputs and resulting output quality. Once produced, the notes must either be distributed or passed to others for distribution, which is a complicated undertaking when large volumes of notes are produced. A bank or an individual might be fooled into accepting a batch of counterfeits once, but it seldom happens more than that. Thus, the notes must be ever more widely dispersed.

Producing high-grade counterfeits requires substantial technical ability and access to presses, inks, and, critically, high-grade paper, but printing technology is improving even as costs decline. Lower-quality counterfeits can also be produced with methods requiring much less skill and can be produced on color copiers or on personal computers that are connected to inexpensive scanner and ink-jet printers.

In rare cases, such as that of the “supernote,” very high grade counterfeits are made using the intaglio printing process in a manner similar to that used by the BEP. The Secret Service has seen a reduction in the necessary skills of a typical counterfeiter, from knowledge of lithographic methods and experience with offset printing to a minimal understanding of personal computers.

The Secret Service expects that the counterfeiting of U.S. currency will become progressively easier as the technology improves and the cost of computer equipment (including printers and scanners) decreases. Counterfeits produced on laser color printers are likely to proliferate with the increased affordability of the printers. Similarly, the growing use of the Internet will also affect counterfeiting. Once a currency note is

scanned and the resulting electronic image is enhanced, the image can be transmitted electronically, including over the Internet, and printed in batches of any size by individuals who lack specialized computer or graphics knowledge.

Of the counterfeit-currency printing operations suppressed inside the United States during fiscal year (FY) 1998, 88 percent were inkjet processes, a phenomenal increase from the FY 1995 level of 19 percent. Even though the quality of inkjet counterfeits varies widely, and even though they are not at present being produced outside of the United States in the same volume as they are domestically, the use of computers in the production of counterfeit notes is likely to increase. Like color laser printers and other personal computer components, inkjet printers are continually increasing in quality and decreasing in price.

6.3 Recent Experience with Counterfeiting

Out of the nearly $500 billion in U.S. dollars in circulation at the end of 1998, the Secret Service reported that about $43 million in counterfeit currency was passed to the public, or about $1 for every $11,600 in circulation.[32] Of that $43 million, almost all ($40 million) was passed in the United States, with the remainder passed overseas. In per capita terms, then, the direct costs of counterfeiting are quite small, about 16 cents per U.S. resident per year. It is also very small relative to the cost of check fraud: In 1995, the latest year for which data are available, the cost of check fraud was $615 million, or nearly twenty times the cost of counterfeiting in that year. In terms of enforcement, the Secret Service counterfeit program in fiscal 1998 resulted in the arrest of 3,569 suspects and the closing of 616 counterfeiting plants in the United States.

6.3.1 Rates of Counterfeiting in Federal Reserve Statistics

Tables 6.1 and 6.2 provide some evidence on the frequency with which counterfeit notes are found in domestic and foreign deposits at Federal Reserve Banks. Table 6.1 shows the overall results by denomination for 1998; the denomination with the

[32] The Secret Service reported that additional quantities were "seized," or confiscated before they entered circulation. In this paper we focus on the figures for "passed" counterfeits. While seized notes pose some threat before they are seized, passed notes clearly cause losses to the public.

Table 6.1
Dollar Counterfeiting Rates in Deposits at Federal Reserve Banks in 1998, by Denomination

Denomination	Total notes processed (millions)	Value of counterfeits detected (millions of dollars)	Counterfeits detected in deposits (per million notes processed)
1	9,177.5	.01	.9
2	13.4	.00	1.6
5	2,071.6	.08	7.9
10	2,384.7	.26	10.8
20	10,715.0	1.70	7.9
50	876.2	.51	11.6
100	1,072.5	6.32	58.8
Total	**26,310.9**	**8.88**	**N/A**

largest amount of counterfeits, both in dollar terms (about $6 million) and as a proportion of notes processed (about 60 per million notes), was the $100 note. The number of counterfeits found among each of the other denominations (per million notes processed) was approximately 1 (for the $1 and $2 notes) and 10 (for each of the denominations from $5 to $50). Table 6.2 breaks down the data for $100s detected at Federal Reserve Banks over the last three years by note design and by origin of deposit. For both types of notes over the whole period shown, the foreign share of detected counterfeits is rather small, around 10 percent for 1996-series (New Currency Design, or NCD) counterfeits and around 20 percent for older-series counterfeits. The bottom panel of table 6.2 provides data on the very highest grade counterfeits, the "supernotes." As noted above, supernotes are printed by the intaglio method, the same method used by the BEP to print genuine notes. In this case, the counterfeit proportion of foreign deposits surpasses that of domestic deposits.

6.3.2 Counterfeiting Outside the United States

Counterfeit U.S. currency is not just a domestic problem. An analysis of counterfeit U.S. currency passed in the United States in fiscal 1998 reveals that approximately 45 percent originated outside of the United States. Prior to 1996, contact

Table 6.2
Counterfeit $100s Detected in Deposits Processed at Federal Reserve, 1996-98

Period	Value (millions of dollars)			Rate: number per million notes processed		
	Total	Domestic	Foreign	Total	Domestic	Foreign
NCD (1996 series)						
1996	.02	.02	.00	.2	.3	.0
1997	.50	.47	.03	4.6	6.3	.9
1998	1.58	1.48	.10	14.7	19.3	3.3
Total	**4.67**	**4.24**	**.45**	**14.0**	**19.8**	**4.5**
Pre-1996 series						
1996	6.81	5.67	1.14	62.2	74.2	34.5
1997	6.72	5.16	1.56	63.0	69.3	48.5
1998	4.75	3.73	1.01	44.2	48.7	33.0
Total	**18.28**	**14.56**	**3.72**	**56.5**	**64.0**	**38.7**
High-quality pre-1996 series ("Supernotes")						
1996					17.3	22.4
1997		NA		NA	16.4	29.8
1998					16.2	21.8
Total					**16.6**	**24.7**

with the Secret Service by foreign law enforcement officials (including INTERPOL) and financial institutions can best be described as inconsistent. Generally speaking, counterfeiting of U.S. banknotes has not been and still is not considered a significant offense in most countries. In addition, there was neither a central repository for counterfeit notes nor a coherent policy for reporting counterfeit activity.

Since the beginning of the ICAP program, many improvements have been achieved in the Secret Service's investigative techniques, data gathering, and above all in relationships with the law enforcement and financial institutions. Field presence has increased, and new offices have been established in key strategic locations. The Secret Service now has permanent offices in fifteen cities: Bangkok, Berlin, Bogota, Hong Kong, London, Manila, Milan, Montreal, Moscow, Nicosia, Ottawa, Paris, Pretoria, Rome, and Vancouver. Through these offices, the Secret Service can more readily respond to counterfeit inquiries, establish contacts with police agencies, offer expert testimony, conduct interviews, and assist in overall investigations. The new offices have

already resulted in the seizing of substantial blocks of counterfeits and arrests that would not have been possible without an immediate presence.

With the introduction of the additional offices and the new data collection systems described in Section 6.1, it is now possible to obtain more comprehensive information on the true state of counterfeiting in terms of production, longevity, and movement within a given geographic region. The newer contacts, principally in Latin America, Russia, and South Africa, coupled with the establishment of extended currency inventories, provide more definitive information relating to criminal activity. As a result, seizures of counterfeits as well as plant closures have increased.

In activities outside the United States, in fiscal 1998 the Secret Service reported seizing $79.7 million in counterfeit currency, the closing of twenty-nine plants, and the passing of $3.1 million in counterfeit currency. While the total of both seized and passed currency is comparable to those for the United States (see table 6.4), many more counterfeits are seized than are passed, according to statistics compiled from foreign sources. Thus, this discrepancy in the Secret Service data is illusory since it reflects in part the fact that information received on counterfeit U.S. notes passed overseas is much less comprehensive than that received for notes passed within the United States. The Secret Service believes that the true quantity of counterfeit notes passed abroad is more likely comparable to that passed inside the United States.

Table 6.3 presents data on the ten most active countries over the last three fiscal years, ranked by the total value of counterfeit currency that was reported to the Secret Service as seized. With the exception of the United States in fiscal 1998, these figures are dominated by the results on seizures. Indeed, Italy is the only country other than the United States in which the amount passed in one year exceeded $1 million. Table 6.4 displays amounts passed and seized, by country, for fiscal 1998. As before, most of the activity in the majority of the countries represents seizures of counterfeits.

Table 6.3

Top Ten Countries in Counterfeits Seized, Fiscal Years 1996-98

Dollars

Economy	Seized	Passed
	FY 1998	
1. Italy	37,614,330	21,560
2. United States	29,942,874	39,954,290
3. South Africa	16,743,200	10,050
4. Germany	4,574,600	89,280
5. Turkey	3,700,300	4,015
6. Colombia	3,444,460	6,846
7. Taiwan	1,800,000	50
8. France	1,500,000	19,920
9. Canada	1,255,400	14,701
10. Dominican Rep.	1,203,400	41,350
	FY 1997	
1. United States	40,385,661	31,750,859
2. Pakistan	11,859,100	450
3. Italy	10,693,720	33,990
4. England	8,734,000	407,505
5. Argentina	4,307,950	43,160
6. Colombia	3,799,110	10,310
7. Germany	2,805,300	77,860
8. Portugal	2,472,100	8,600
9. South Africa	2,155,500	900
10. Mexico	2,002,520	186,810
	FY 1996	
1. United States	63,691,115	29,831,108
2. Colombia	36,87,1730	10,650
3. Italy	19,759,540	2,308,800
4. Germany	19,041,830	523,630
5. Yugoslavia	5,863,300	320
6. England	5,218,430	104,035
7. Greece	2,772,900	2,670
8. France	2,407,800	59,800
9. Canada	2,127,480	32,150
10. Sweden	2,066,000	300

Table 6.4

International Counterfeiting Statistics for Fiscal Year 1998, Ranked by Total Dollar Value of Counterfeits Reported

Dollars

Economy	Passed	Seized	Total
Italy	21,650	37,592,680	37,614,330
South Africa	10,050	16,743,200	16,753,250
Germany	89,280	4,574,600	4,663,880
Turkey	4,015	3,700,300	3,704,315
Colombia	6,846	3,444,460	3,451,306
Taiwan	50	1,800,000	1,800,050
France	19,920	1,500,200	1,520,120
England	280,360	1,061,900	1,342,269
Canada	14,701	1,255,400	1,270,101
Dominican Republic	41,350	1,203,400	1,244,750
Finland	2,700	1,092,500	1,095,200
Thailand	6,770	631,260	638,030
Azerbaijan	200	597,500	597,500
Poland	6,770	521,000	527,770
Egypt	20,220	451,520	471,740
Panama	72,990	373,000	445,990
Namibia	21,350	364,020	385,370
Greece	300	377,200	377,500
Netherlands	166,040	195,170	361,210
Belarus	300	325,800	326,100
The Gambia	0	250,100	250,100
Mexico	208,850	2,885	211,735
Georgia	0	200,000	200,000
Hong Kong	192,235	6,200	198,435
Kyrgyzstan	0	192,300	192,300
United Arab Emirates	184,900	0	184,900
Switzerland	171,191	12,300	183,491
Argentina	18,950	152,500	171,450
Israel	12,450	140,200	152,650
Monaco	144,500	200	144,700
Malawi	139,590	0	139,590
Spain	44,310	76,350	120,660
Albania	101,620	16,900	118,520
Austria	71,215	41,750	112,965
Venezuela	3,280	100,900	104,180
Total outside the United States	3,113,775	79,665,935	82,779,710
Memo:			
Total inside the United States	39,954,290	29,942,874	69,897,164

6.4 Counterfeiting in Key Countries and Regions

Six countries and one region deserve special mention in enumerating the responses that the Secret Service has developed to deal with the counterfeiting threats posed abroad: Russia, Colombia, South Africa, Germany, Italy, Vietnam, and the Middle East. Russia has the most U.S. currency of any country besides the United States and by all indications produces a substantial quantity of counterfeits, some of which circulate within Russia. Colombia registers on counterfeiting threat lists for one reason: It is a very important supplier of counterfeit notes to the U.S. market. Relatively high quality Colombian counterfeits have been successfully imported into the United States for several decades. The South African threat arose much more recently but appears to be growing relatively quickly. It was not on the list of countries (including the United States) having activity levels in the top ten in 1996. But in 1997 it was ninth on the list before moving up to third in 1998. Germany, Italy, and Vietnam have also been the sites of notable developments. Finally, the Middle East has a significant quantity of both genuine and counterfeit U.S. currency in circulation.

The Secret Service believes that the strategic placement of personnel overseas promotes better police operations because it permits Secret Service agents to respond more promptly and consistently. In time, the long-standing relationships that develop from day-to-day interactions and the ability to focus consistently on ongoing problems encourages foreign law enforcement counterparts to increase the priority given to this type of investigation. In locations where a permanent presence is not possible, the Secret Service employs task forces to target regions with large amounts of counterfeit currency.

6.4.1 Colombia

Colombia is important both because it is in the top ten countries by value of seized counterfeits and because it is the most important source of counterfeits flowing into the United States. During FY 1998, 36 percent of counterfeit currency passed within the United States originated in South American countries and, of that, 97 percent came from one country, Colombia. Because high volumes of Colombian counterfeits have been entering the United States for many years, in 1997 the Secret Service established the

South American Task Force (SATF) in Bogota, Colombia.[33] The SATF and the Secret Service's Miami Field Office, Bogota Resident Office, and Counterfeit Division have been instrumental in training South American law enforcement agencies in the detection, interdiction, and suppression of counterfeit U.S. currency. During the course of several investigations, the SATF identified distribution networks, methods of concealment, contraband exchange procedures, informants and target cities. In December 1998, the Bogota Resident Office was expanded from one to two agents.

Many Colombian counterfeiters are able to avoid significant jail time when they are arrested by simply paying an administrative fine. The fact that many of those arrested are repeat offenders indicates that arrests are not much of a deterrent in Colombia. This issue has been repeatedly addressed in various meetings with Colombian officials, including the currency audit delegation from the Treasury and Federal Reserve to Colombia in October of 1998.[34]

Table 6.5 highlights some of the SATF statistics for 1998, when Columbia ranked fifth in overseas currency seized. While the arrest record represents an improvement in part due to the presence of the resident agent in Bogota, as mentioned above, the deterrent effect of arrests remains limited.

[33]The SATF consists of representatives from five law enforcement organizations: Departamento de Investigaciones Judiciales de Inteligencia (DIJIN), the Colombian National Police, the Cuerpo Tecnico de Investigaciones (CTA), the Departamento Administrativo de Seguridad (DAS), and the Secret Service.

[34]In September 1998, Secret Service officials were informed that changes in the Colombian penal code, including an increase in the current six-year maximum conviction and the elimination of a defendant's ability to pay a fine in lieu of incarceration, have been proposed in the Colombian Congress.

Table 6.5
Counterfeiting Data for Key Countries

Country	Fiscal year	Seized (dollars)	Passed (dollars)	Arrests	Plant suppressions
Colombia	1998	3,444,460	6,846	26	6
South Africa	1998	16,743,200	10,050	NA	NA
Italy	1996	19,759,540	2,308,600	NA	NA
	1997	10,693,720	33,990	NA	NA
	1998	37,592,680*	21,650	NA	NA

* Of this amount, about $30 million was seized in a single case.

6.4.2 South Africa

South Africa is becoming a major producer of counterfeit U.S. currency. For the last two fiscal years, South Africa has been one of the top ten countries in the production of counterfeit Federal Reserve notes. In fiscal 1998, only Italy and the United States surpassed South Africa in the value of counterfeits seized within the country. Representatives of South African Police and agents of the Secret Service, working under the direction of the Secret Service Field Office in Rome, formed the South African Task Force in 1998 to target this problem. In addition, the Secret Service established an office in Cape Town early in 1999.

6.4.3 Italy

The Secret Service established the Milan Task Force in 1985 to combat an existing counterfeiting problem in Northern Italy. Counterfeit notes produced in this area have traditionally been of better than average quality, occasionally being produced using intaglio printing processes. In 1996, the Secret Service expanded its presence in Italy by adding a new permanent office in Milan. The additional Secret Service presence in Italy has resulted in substantial arrests and seizures. Nonetheless, Italy has been one of the top three producers of counterfeit currency during the past three fiscal years.

6.4.4 Germany

In 1996, the Bonn Resident Office became a permanent installation of the Secret Service under the Paris Field Office. This office has established strong working relationships with law enforcement agencies in Germany, Austria, and Poland. In conjunction with their foreign law enforcement counterpart agents, the Bonn Resident Office seized approximately $19 million, $3 million and $4.5 million, respectively, in counterfeit U.S. currency in FY 1996, 1997, and 1998.

6.4.5 Russia

Counterfeiting activity in Russia is a major concern due to the large amount of genuine United States currency in circulation there and, as such, must remain a major focus for the Secret Service. Data from both Russian banks and the Federal Reserve indicate that the incidence of counterfeits in circulation in Russia is similar to that found elsewhere, contrary to misleading reports circulating in the mid-1990s. Nonetheless, more recently, the Secret Service and other law enforcement agencies worldwide have witnessed an increase in Russian defendants involved in counterfeit operations, and other crimes, throughout Western Europe. The Secret Service opened an office in Moscow early in 1999, which has strengthened its ability to conduct investigations and gather evidence.

6.4.6 Vietnam

The ICAP visit to Vietnam in 1996 led to the development of ongoing liaisons with the Ministry of the Interior for Vietnam. For some time the Secret Service had been seeking the cooperation of the Vietnamese police, but with little success. During this visit, the Minister of the Interior had questions about some recently received high-quality counterfeits and was thus happy to arrange a meeting with the team. Officials from the Ministry of the Interior were very open at the meeting and laid out many details on about thirty cases involving a total of $344,600 in counterfeit U.S. currency during the last four years. The Secret Service is hopeful that this level of cooperation will continue.

6.4.7 Middle East

A permanent office was established in Nicosia, Cyprus in 1996. This office has oversight of all Middle Eastern Countries. Not unexpectedly, establishing and maintaining contacts with many foreign governments in this part of the world is complex. Officials representing the United States Government (law enforcement or otherwise) are routinely received with caution. It has proven to be particularly difficult to pursue counterfeiting in Lebanon and Syria, especially in the Bekaa Valley. Despite these obstacles, Secret Service agents have made significant progress in developing sound working relationships with a number of law enforcement agencies in this region. This cooperative effort has been successful in leading to a number of plant suppressions and seizures in Lebanon.

6.5 The Changing Nature of the Counterfeiting Threat

Historically, the Secret Service has been effective in keeping counterfeit production in check in the United States, but it faces a constant battle to keep abreast of improvements in technology that make counterfeiting easier and cheaper. A few years ago, computer-generated notes were generally of poor quality. The computer printers of that period were mostly dot matrix and the software available could not generate copies of sufficiently high resolution to be deceptive. In contrast, it is estimated that 43 percent of the households in the United States now have computers, most with full-color monitors. Full-color inkjet printers have become a reliable and low-cost alternative to the more expensive laser color printers, and are now readily available and highly affordable: A good inkjet color printer can cost as little as $100, which is also about the cost of a good color scanner. In 1997, the worldwide population of inkjet printers was 60 million, a number that is expected to more than double by 2000 to 125 million. Basic economic theory suggests that when entry costs into an industry fall, the number of firms willing to supply a good will increase. Unfortunately, this proposition holds for counterfeits just as it does for shoes.

The value of counterfeit currency passed in the United States over the three fiscal years 1995–1997 was fairly stable; however, in FY 1998 it increased by about a third,

from around $30 million to around $40 million. Technological advancements in the printing field have contributed to this increase. Since the emergence of newer methods of

Table 6.6
Inkjet Counterfeit Activity within the United States

	Inkjet notes passed		Plant suppressions			Arrests		
Fiscal year	Value (thousands of dollars)	Share (percent)	Total	Inkjet	Inkjet share (percent)	Total	Inkjet-related	Inkjet-related share (percent)
1995	175	0.5	153	29	19	1,856	37	2
1996	760	3	198	101	51	1,137	176	10
1997	6,121	19	435	321	74	2,436	1,100	45
1998	17,050	43	616	547	88	3,569	2,618	73

producing counterfeit banknotes, the percentage of inkjet counterfeit notes has dramatically increased, as seen in table 6.6. Many inkjet-produced counterfeit notes are of lesser quality than notes produced on offset presses, but their quality is high enough to deceive many commercial establishments. In addition, as shown in the middle columns of table 6.6, the dramatic increase in the supply of inkjet counterfeits has led to a concomitant sharp increase in plant suppressions and related arrests. It should be noted that this phenomenon is not exclusively or even mainly a juvenile problem: Only 17 percent of today's inkjet counterfeit cases involve juveniles.

Thus far, the problem of inkjet notes is largely a domestic one, reflecting the fact that the United States has a knowledgeable and widely dispersed group of personal computer users. However, as the personal computer revolution moves worldwide, it is reasonable to predict that the inkjet counterfeit usage will follow.

In addition to the fact that it may be more difficult to find inkjet counterfeiters, it is more difficult to prosecute and punish suspects who use computers to generate counterfeit currency. Traditionally, there have been significant sentencing enhancements for defendants based on the amount of counterfeit currency they have either produced or passed. While the offset counterfeiter normally will produce a large amount of counterfeit currency during each run because of the time and expense necessary to conduct each run, the inkjet counterfeiter can efficiently make counterfeit currency in small batches. Thus,

although inkjet counterfeiters have the potential to produce large quantities of currency, they are unlikely to receive heavy sentences because they are unlikely to have large holdings of counterfeit notes at any one time.

In sum, fighting counterfeiting in the near future will be dominated by three factors. First, the 1996-series notes will continue to displace older notes, and future design changes in U.S. currency will render it even more resistant to counterfeiting. These notes have been widely accepted, and are more resistant to counterfeiting. Second, the technology used to produce counterfeit currency is becoming easier and cheaper to use and acquire, making the use and awareness of counterfeit-resistant features more important. Third, partly as a result of the earlier phase of this project, communication among countries about counterfeiting is improving, making enforcement efforts more efficient.

7 Global Estimates of Counterfeiting

This chapter presents the calculations that form the basis of a point estimate and upper bound on the quantity of counterfeits in circulation. The estimates are based on counterfeit data collected by the Secret Service and Federal Reserve together with current understanding of circulation patterns for genuine and counterfeit currency. The value of counterfeits in circulation is most likely around $70 million, or fewer than 1½ in 10,000 notes, with about 60 percent of these held overseas. The upper bound is estimated to be about $150 million, or about 3 in 10,000 notes.

Very good sample data on counterfeits are available from two sources that can be considered independent in various dimensions. Both sources suggest that the incidence of counterfeits in the population is quite small, on the order of one note in 10,000 for $100 notes.[35] In order to develop appropriate confidence bounds for extrapolation, we compare the data from these two sources. In addition, using currency-processing data, we are able to estimate the degree to which the currency received by the Federal Reserve is likely to represent the total population of currency outstanding. We also consider the impact on the estimates of the currency that circulates only infrequently through Federal Reserve processing centers. We conclude that it is unlikely that pockets containing large numbers of counterfeits exist for very long outside the banking system.

In sum, then, counterfeiting is not currently a very serious problem. However, historical evidence indicates that the level of counterfeiting remains low precisely because it is diligently monitored and punished.[36] As mentioned previously, technological advances aid both the Secret Service, which is in charge of enforcing counterfeiting laws, and the counterfeiters, who use all available tools to attempt to perpetrate a very lucrative type of crime. Thus, counterfeiting will remain in check only as the Secret Service is able to act vigorously to prevent it.

The first section describes a general economic model that explains the level of counterfeiting. The second section reviews the data sources available, and presents comparisons of the two major datasets. The third section presents our estimates. The

[35]We focus on $100 notes here because they account for about two-thirds of the value of currency in circulation and about 80 percent of the value of counterfeits passed.

[36]This conclusion is also supported by the analytical model of counterfeiting that we consider in section 7.1.

fourth section presents estimates of how representative the notes that pass through the banking system are and presents a model of currency circulation that demonstrates that it is quite unlikely that a large pool of counterfeits can circulate undetected. The fifth section concludes.

7.1 Theoretical Work

The few theoretical papers on the economics of currency counterfeiting conclude that there are only two possibilities for long-run equilibrium, either very low or very high levels of counterfeiting. There is no middle level of counterfeiting. More specifically, given the actual level of enforcement against counterfeiting and the level of counterfeit deterrence in the genuine notes, there are two alternative equilibria that the economy can reach: Either counterfeit currency takes over, as in a situation in which Gresham's law holds, that is, bad money drives out good, or counterfeit notes hardly get any foothold whatsoever (Lengwiler, 1997). In Lengwiler's model, the equilibrium that actually occurs is a function of the note's production cost (that is, the difficulty of counterfeiting it) and its face value. The monetary authority is more likely to invest more in higher-cost notes and thus insure a near-zero-counterfeiting equilibrium the higher is the cost of counterfeiting and the higher is the value of the note. U.S. banknotes, especially the pre-1996 series, had significantly fewer counterfeit protection devices than the banknotes of many other industrialized countries and were low in value relative to other countries' currency issues.[37] However, as Green and Weber (1996) point out, the technology now embedded in the new-design 1996-series $100 approaches that of other countries' currency.

Clearly, if the high-counterfeiting equilibrium had some real-world relevance, one would not observe the large demand for dollars that exists in most parts of the world. Rather, the other, low-counterfeiting equilibria in Lengwiler's model appear to be consistent with the actual data on counterfeiting in which the frequency of counterfeits is on the order of only 1 in 10,000. Interpreting these outcomes from the economic model described above, it appears that the level of counterfeiting deterrents embedded in U.S.

[37]The highest denomination now issued is $100. In contrast, many other countries issue denominations with values between $500 and $1000.

notes, combined with the level of law enforcement provided by the Secret Service and its foreign counterparts, has been adequate to keep the economy operating at the low counterfeiting state, given the two possible equilibria that could occur.

7.2 Data Sources

The two primary sources of data on counterfeiting are the Secret Service and the Federal Reserve. In addition, this project has obtained some institutional knowledge from banks, currency dealers, banknote shippers, and other officials responsible for currency distribution and counterfeit detection around the world.

7.2.1 Secret Service Data

The Secret Service collects data on all counterfeits found in the United States as well as all counterfeits they seize or receive abroad. For every counterfeit obtained, the Secret Service records its characteristics and the location of its discovery. Their statistics for notes that are seized before being put into circulation are kept separately from those for counterfeits detected while in circulation. This distinction is important for the estimates of counterfeits in circulation, in which we focus on the notes that were passed (actually used in at least one transaction). While the number of notes seized is important from a law-enforcement perspective, only the notes that were actually in circulation generate an economic loss to the general public.

Although the Secret Service data are the most comprehensive available, the data on the passing of counterfeit dollars outside the United States are incomplete for two major reasons: First, counterfeit U.S. dollars found abroad may be retained by banks, returned to customers, or held by local law enforcement authorities without being reported to the Secret Service; second, the capacity of the Secret Service itself to detect and seize counterfeit U.S. currency overseas is directly proportional to its ability to develop connections with the relevant officials overseas--detection of counterfeits is highest in countries where the Secret Service has the best ties with local law enforcement agencies. As shown in the upper panel of table 7.1, the amount of counterfeit currency

Table 7.1

Data on Counterfeits for Calendar Year 1998

Millions of dollars except as noted

		Domestic	Foreign[1]	Total
Secret Service	Counterfeit $100s passed	26.5	2.2	28.7
	Counterfeit $100s seized	26.5	53.3	79.8
	All counterfeits passed	39.4	2.4	41.8
	All counterfeits seized	30.0	56.2	86.2
Federal Reserve System	Counterfeit $100s detected	5.2	1.1	6.3
	All counterfeits detected	NA	NA	8.9
	Detection rate for counterfeit $100s, notes per million	68.0	36.3	58.8
	Detection rate for all counterfeits, notes per million	NA	NA	22.2

Note. "Seized" refers to counterfeit currency that was detected before being circulated, while "passed" indicates currency that was determined to be counterfeit after entering circulation. Only passed currency represents a loss to the public; seized counterfeits represent only a potential threat.

[1]Includes foreign data for New York, Miami, El Paso, Houston, San Antonio, San Francisco, and Los Angeles.

passed (and detected) in the United States in 1998, $39.4 million, was comparable to the amount the Secret Service seized (that is, intercepted before it was circulated) in the United States, $30.0 million. Outside the United States, however, the amount of counterfeit U.S. currency reported as seized is much higher than the amount reported as passed ($56.2 million and $2.4 million respectively). Because some counterfeits found outside the United States are not reported to U.S. authorities, the Secret Service believes that the true amount of U.S. notes passed abroad is much larger than the reported amount and perhaps comparable to the amount seized abroad.

7.2.2 Federal Reserve Data

Each of the thirty-seven Federal Reserve Cash Offices collects data on its cash processing activities, including counterfeit detection. These data are useful in three ways. First, the New York City Cash Office, which is the major port of entry and exit for international shipments of U.S. dollars, has very recently gained the ability to identify the city and country of origin for many of the counterfeits it receives. These data, which cover notes that by definition have been returned to the United States, complement the

Secret Service data, which cover notes detected abroad or, in the taxonomy mentioned in the introduction, are circulating but remain outside the Federal Reserve. Thus, the correlation between these two sources can be used to calculate confidence bounds for the population of notes in circulation as a whole. Because these data have been developed only recently, however, we present only some preliminary results to demonstrate that the samples reveal broadly similar distributions of counterfeits by country. Overall, the Federal Reserve detects about 20 percent of all counterfeits reported to the Secret Service.

The second use of Federal Reserve processing data comes from the fact that separate statistics are recorded for three classes of notes: All pre-1990 series, the 1990 series, and the 1996 series.[38] About 30 percent of all $100 notes outstanding passed through Federal Reserve Cash Offices at least once in the twelve months after the introduction of the 1996-series $100 note, but the notes processed are almost surely not a random sample of all notes outstanding. Notes circulating within the United States are likely to return to Cash Offices more quickly than overseas notes in remote areas and areas where dollars are used more as a store of value than as a medium of exchange. The information on the series date of notes, however, can be exploited to obtain estimates of how much of the total currency population is in "active" circulation and how much might be hoarded.

The third use of Federal Reserve processing data is the most direct: From counterfeit detection rates and total processing figures, we can estimate the incidence of counterfeits among the stock of dollars circulating actively.

7.3 Estimating the Total Quantity of Counterfeits in Circulation Worldwide

We have made three sets of calculations to estimate the total amount of counterfeit currency now in circulation. First, we generated a lower bound for the total

[38]The first 1990 series notes were issued in 1991 and include a security thread and microprinting. The 1996-series notes, of which only the highest three denominations, the $100, $50, and $20 have been issued so far, were first issued in 1996, in the $100 denomination. Among the security features of the latest series are a larger portrait, a reflective security thread, a watermark, additional microprinting, and optically variable (color-shifting) ink.

number of $100 counterfeits based on Federal Reserve cash processing data. Second, we generated an upper bound for $100 counterfeits by extrapolating from Federal Reserve data to cover counterfeits found outside the Federal Reserve. Third, we generated a range of plausible estimates for all denominations based on the relative incidence of $100 counterfeits and lower-denomination counterfeits. We conclude that the total value of counterfeits in circulation at any moment is on the order of $70 million, or fewer than 1.5 notes in 10,000, and is highly unlikely to exceed $140 million, or fewer than 3 in 10,000. Further, we conclude that the incidence of counterfeits is roughly the same inside and outside the United States, and thus the distribution of counterfeits follows the estimated distribution of genuine currency, which is estimated to be about 50 to 70 percent abroad and the remainder within the United States.

7.3.1 Estimating the Minimum Stock of $100 Counterfeits in Circulation

The Federal Reserve records how many of the counterfeit U.S. notes it detects originated abroad and how many originated domestically. However, the exact amount of U.S. currency held abroad is unknown, so we use a range of assumptions about how much U.S. currency is abroad in estimating confidence bounds for the total number of $100 counterfeits (table 7.2). For shares of currency held abroad ranging from 40 percent to 70 percent, we present the counterfeit detection rate per million notes and the implied value of counterfeit notes.[39]

The Federal Reserve processing data suggest that the total stock of $100 counterfeits outstanding is in the range of $15 million to $19 million, a figure we consider to be a lower bound for several reasons. First, the notes sent to Federal Reserve Cash Offices are a relatively "clean" sample of the population of all notes in circulation

[39] Although the estimates in Porter and Judson (October 1996) put the share of currency abroad between 55 and 70 percent, Feige (1996) presents estimates as low as 40 percent.

Table 7.2

Counterfeit $100 Stocks Implied by 1998 Federal Reserve Processing Data

Location	Detection rate (notes per million)	Assumed share at location (percent)	Value of genuine notes (billions of dollars)	Implied counterfeits (millions of dollars)
Total	**58.8**	**100**	**320.1**	**18.8**
Domestic	68.0	60	192.1	13.0
Foreign	36.3	40	128.0	4.6
Total	. . .	. . .	. . .	17.7
Domestic	68.0	30	96.0	6.5
Foreign	36.3	70	224.1	8.1
Total	. . .	. . .	. . .	14.6

in that the notes have already passed through several detection "screens" before reaching the Federal Reserve. If a counterfeit is deposited at a commercial bank, the probability that it will remain in the stock of notes sent on to the Federal Reserve is less than one, and most likely substantially less than one. Once a counterfeit finds its way to a commercial bank, there are four distinct possibilities for its disposal. First, it could be (a) accepted, sorted, and then resold or (b) sent to the Federal Reserve. In the latter case, it would appear in the Federal Reserve processing data.[40]

Second, it could be confiscated as a counterfeit and reported to the police and Secret Service. In this case, the note appears in the Secret Service's statistics but not in the Federal Reserve's statistics.

Third, it could be returned to the depositor (although virtually no U.S. banks return suspected counterfeits to depositors).[41]

Fourth, the bank could confiscate the note as counterfeit but either not report the note to the police and Secret Service or not release it. Banks are often eager to retain a few counterfeits for the purpose of training their own tellers. In some countries, banks are permitted to report counterfeits and then retain the notes. This set of notes thus does not

[40]We assume that the Federal Reserve detects all counterfeits in shipments it receives. For a discussion of this assumption, see Allison and Pianalto (1997).

[41]Nearly every central bank in the world, including the Federal Reserve, forbids this behavior on the part of local banks and currency exchanges, but some evidence and our ICAP visits suggest that it occurs with some regularity.

appear in the Federal Reserve statistics but may or may not appear in the Secret Service statistics. Counterfeit detection at commercial banks is generally quite good, so we believe that the majority of counterfeits that arrive at banks do not get shipped to the Federal Reserve. The fact that the Secret Service receives four times as many passed counterfeits as the Federal Reserve would seem to bear this out.

We believe that a counterfeit arriving at a foreign bank is less likely than a counterfeit arriving at a U.S. bank to be delivered to the Secret Service or to make it into a Federal Reserve deposit for two reasons. First, U.S. banks are more likely than their foreign counterparts to contact the Secret Service directly. Second, on average, overseas banks appear to check their dollar shipments more carefully for counterfeits, partly because labor costs are so much lower in many countries with heavy dollar traffic. As a result of the higher level of screening, the incidence of counterfeits from foreign deposits is slightly less than half of that for domestic deposits in recent years (see table 7.2).

7.3.2 Using Federal Reserve and Secret Service Data to Estimate the Total Stock of $100 Counterfeits in Circulation

We now return to the estimate of the total stock of counterfeits. As noted above, a lower bound for the estimate of $100 counterfeits in circulation is $15 million to $19 million. Within the United States, four counterfeit $100 notes are detected outside the Federal Reserve for each one found by the Federal Reserve. An estimate of counterfeit $100s in circulation based on this ratio would be about $75 million to $100 million. This estimate, however, should be viewed as an upper bound, for reasons similar to those discussed above. The counterfeits found outside the Federal Reserve are, in general, of lower quality and more easily detected (hence their detection outside the Federal Reserve). Thus, they probably do not circulate for as long as the counterfeits that survive until reaching the Federal Reserve.[42] A middle-range value of about $50 million, or less than 1 counterfeit $100 in every 6,000 $100 notes in circulation, is the most likely estimate.

[42]Appendix B takes up the issue of the lifespan of a counterfeit.

7.3.3 Extrapolating from $100 Counterfeits to All Counterfeits

Table 7.1 indicates that $100 counterfeits are 68.7 percent of all counterfeits recorded by the Secret Service and 70.8 percent of all counterfeits found by the Federal Reserve. Extrapolation from the estimates for the $100 note suggest that the $50 million baseline should thus be inflated by a factor of 1.41 to 1.46, for a total of about $70 million to $75 million, or 1.5 counterfeits in 10,000 notes. If we extrapolate from the upper and lower bounds discussed above, the lower bound estimate for counterfeits of all denominations is about $25 million, or 0.5 in 10,000 notes, and the upper bound is about $140 million, or 2.8 in 10,000 notes.

7.4 The Next Step: How Unrepresentative Are Our Data?

The estimates constructed above rely heavily on the assumption that the samples are representative. However, the samples could be unrepresentative along several dimensions. First and most crucially, suspected counterfeit notes could perhaps find their way into an isolated pool of currency that never reaches the banking system. Second, notes from some countries could be returned for processing more readily than others. Third, counterfeit detection capability could vary widely across countries.

In appendix B, two models show why notes are unlikely to remain outside the banking system indefinitely. The first model (B.2) shows that notes in active circulation almost surely return to the banking system relatively quickly. The second model exploits cash processing data to estimate the shares of currency at home and abroad that might be hoarded, that is, held out of circulation for several months or more. Both of these models suggest that large quantities of counterfeits cannot hide anywhere for very long. With regard to the third concern, the relatively close match between Secret Service data and Federal Reserve data suggests that the country distribution of counterfeits is unlikely to be radically different from what is observed in the available counterfeit data.

7.4.1 Hoarding: Some Empirical Evidence from the Team's Travels

One cannot rule out the possibility that a large batch of counterfeits has been inadvertently hoarded along with genuine notes, but a recent episode in Korea suggests that fears about this problem are overdrawn.

After the sharp depreciation of the Korean won in the fall of 1997, Korea introduced a program in which citizens were encouraged to deposit their dollar holdings with the government to help resolve the financial crisis that had arisen that year. At the time of the call for dollars, counterfeiting in Korea could have been a large problem. Korea was one of the very few countries in Asia that had traditionally been willing to accept fit (previously circulated) notes in its wholesale shipments of notes; wholesale shipments are likely to contain counterfeits, whereas shipments of new notes are necessarily free of them.

Under a program by the Korean government to acquire dollars and other assets, the government collected $2.2 billion in U.S. currency from Korean residents during a grace period in January and February 1998. During the grace period, the government agreed to not question the source of any funds turned in. The dollars were all carefully inspected for counterfeits. In this repatriation of stockpiled currency, which must be one of the largest ever conducted, Korean officials found only 0.012 percent to be counterfeit, or $264,000. That is, they found counterfeits at the rate of 1.2 counterfeits per 10,000 notes, a result on a par with counterfeit incidence elsewhere in the world.

Thus, this natural experiment suggests that the existence of significant stockpiles of currency does not necessarily imply the existence of a serious counterfeiting problem. More generally, since unexpected events continually lead individuals to draw upon their precautionary holdings of currency, the stockpiled currency is always being sampled.

7.4.2 Pools of Undetected Counterfeits

Perhaps some counterfeits circulating abroad escape detection by circulating as part of a pool of U.S. currency that (1) never enters the banking system or enters banks that don’t detect the counterfeits and (2) in any case never returns to the United States, where the counterfeits would almost certainly be discovered.

This is a highly unlikely set of conditions. On our visits, we observed that counterfeit detection capabilities are very good at central banks, commercial banks, and authorities charged with stopping counterfeiting and that the condition of the circulating currency was reasonably good. These observations made it apparent that counterfeits do not endlessly circulate outside the banking system in any of the markets we visited.

Currency is used for a wide range of transactions, but even in gray or black market economies, it will eventually find its way into a commercial banking institution, most likely after being used in relatively few transactions.[43] We present a more formal model of these ideas in appendix B.2.

7.4.3 Comparing the Country Distribution of Counterfeit Notes

Below we present two comparisons of three data sets that have been assembled largely independently of one another. The comparisons point to similar estimates for the distribution of counterfeits, which in turn suggest that, despite the shortcomings of the data sets, they are representative of currency and counterfeiting activity worldwide. First, we compare the counterfeiting data from the Federal Reserve with that from the Secret Service. Second, we compare the counterfeiting data from the Secret Service with the Federal Reserve estimates of the amount of genuine currency circulating overseas.

7.4.3.1 Comparing the Counterfeiting Data

In principle, the country-by-country data on counterfeits detected at the Federal Reserve Cash Offices should be a subset of the Secret Service data. Under certain conditions, moreover, the proportions of counterfeits detected by country and region should be similar in both data sets. However, neither of these conditions holds exactly in the data we present here, and as a result, the ratios do not exactly coincide, though most observations do fall within two standard deviations of the mean absolute deviation.

Two conditions are necessary for the country-specific counterfeiting data sets to exactly match both each other and the true country distribution of counterfeits. First, the Secret Service's ability to detect counterfeits would have to be exactly uniform across countries, which is surely not the case given variation in staff size, relations with local law enforcement, and other local factors. Second, the notes processed by the Federal

[43] One application of the isolated pools theory has been in stories that one or more governments hostile to the United States had obtained genuine plates for printing U.S. currency and were producing a flood of counterfeits to destabilize the dollar. Part of the scenario was the assertion that these counterfeits could circulate endlessly and freely within the bounds of such countries. We have no way of confirming or denying such stories. If closed countries do indeed have many counterfeits in circulation, it is impossible to know so long as the system remains closed. The evidence and model we present here apply to *open* markets. Moreover, in a closed system in which everyone is aware of the counterfeits, the loss to consumers and potential for destabilization is not clear.

Reserve would have to be a random sample of the notes in circulation in a given country. This condition is somewhat more likely to hold. Although some currency is held for long periods, and some currency is selected for return to the United States because it is unfit, our estimates below on hoarding suggest that notes circulate fairly randomly.

The Secret Service data used here cover only notes passed to the public; they do not include notes seized, since these notes by definition were never in circulation. The figures used here are for the latest available period, January–October 1998. Since the Secret Service dataset includes counterfeits found by the Federal Reserve, the Secret Service's figure for each country should be greater than the Federal Reserve's figure. Countries are dropped if the Secret Service's records show fewer counterfeits than the Federal Reserve's records.

Each point in figure 7.1 represents one country's share of the counterfeits detected in each data set. Thus, a point at (5.0,10.0) would indicate that 5 percent of the counterfeits detected at the New York Federal Reserve Cash Office came from that country while 10 percent of the counterfeits detected by the Secret Service did. These points would all lie on the 45-degree line if the relative detection rates between the two data sets agreed and if the samples of notes processed were exactly representative of the notes in circulation. The dashed lines represent a 95 percent confidence interval around the 45-degree line. Since most of the points associated with the individual country pairs lie within the confidence band, we cannot reject the hypothesis that the relative detection rates in the two data sets are not significantly different from one another.

Figure 7.1

Shares of Counterfeits Found in Various Countries, January–October 1998

Percent

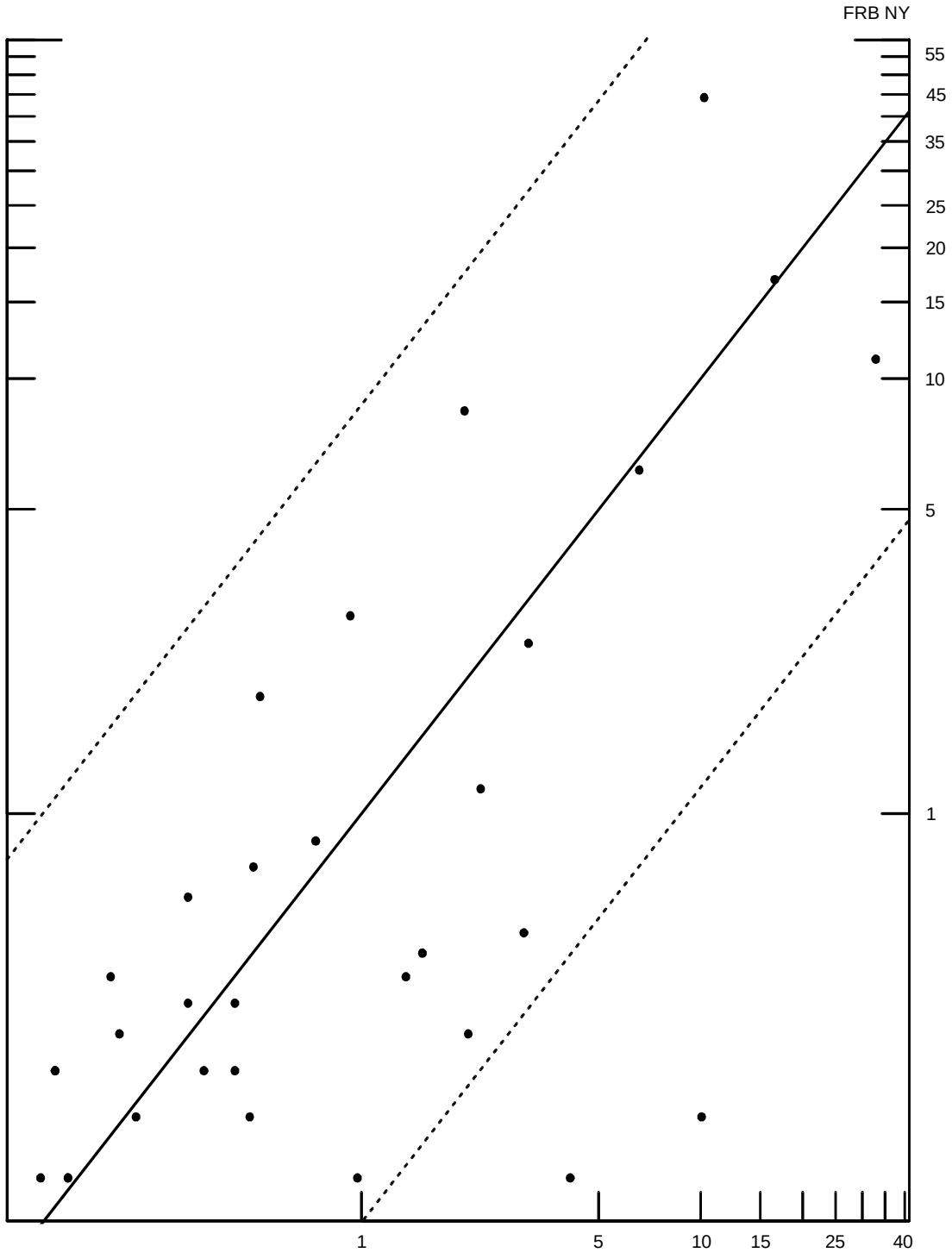


Table 7.3

Expected and Actual Distribution of Counterfeits

Percent except as noted

Region	Expected counterfeits (dollars)	Actual counterfeits (dollars)	Currency distribution	Counterfeit distribution
(1)	(2)	(3)	(4)	(5)
Africa and the Middle East	387,182.80	311,825.00	20.0	16.1
Americas	435,580.70	400,734.20	22.5	20.7
Asia	338,785.00	298,966.00	17.5	15.4
Europe and the former USSR	774,365.60	924,604.00	40.0	47.8

7.4.3.2 Testing the Location of Counterfeits with Dollar Estimates in Various Parts of the World

Are the data on counterfeit dollars found in various locations outside the United States in basic agreement with our understanding of the distribution of all dollars in broadly defined regions? Presumably, counterfeits cannot easily "hide" among genuine notes when the number of counterfeits is relatively large. If the proportion of counterfeit currency supply is growing in a region, holders of the currency will eventually learn about the counterfeiting problem and become more wary of acquiring a counterfeit in their day-to-day transactions. Thus, if counterfeit dollars are dispersed throughout the world up to the point at which residents of any country would become suspicious of their dollar holdings, the distribution of counterfeits across the world might match that of the currency as a whole. The proposition ignores the costs of distributing counterfeits, which are not necessarily likely to be evenly distributed across parts of the world.

Table 7.3 compares the percentage distribution of currency holdings in four regions: Africa and the Middle East, the Americas, Asia, and Europe and the countries in the former Soviet Union. This distribution combines the best judgmental information at the Federal Reserve about the distribution of currency (column 4) with the Secret Service's data on the distribution of counterfeits that were passed into circulation

(column 5).[44] Columns 2 and 3 list the expected and actual distribution of counterfeits under the assumption it is proportional to currency holdings in these four broadly defined regions. A standard statistical test of these data suggests that the counterfeit and currency distributions match each other in terms of the relative amounts found in each of these four regions.[45]

7.5 Conclusion

In sum, we estimate that about $70 million, or fewer than 1.5 counterfeits per 10,000 notes, might be in circulation at any one time. In addition, we consider a range of $25 million to $140 million, or between 0.5 and 2.8 counterfeits in 10,000 notes, to be an exhaustive confidence interval. It is indeed possible that a large number of counterfeits could be injected into the financial system, but they would likely be detected and removed fairly quickly given what we know about cash transactions and the banking system. We believe that the close correlation between the country distribution of currency holdings and the counterfeits detected by the Federal Reserve and the Secret Service is strong evidence that both counterfeit detection and incidence fall within a small range throughout the world.

[44] The counterfeits that could not be assigned to any region by the Secret Service were assigned according to the distribution of those that could be assigned. Information on seized (never circulated) notes is not used because they are irrelevant to the question of interest, which is how easy or difficult it would be to pass counterfeits.

[45] The test statistic of the null hypothesis that the points lie on the 45 degree line has a value of 1.0 and is distributed as a chi-square with 3 degrees of freedom.

8 Summary and Conclusions

This study reports the results of a joint Treasury and Federal Reserve investigation of currency usage and counterfeiting activities abroad. Activities consisted of study trips to areas of the world where dollars circulate and, subsequently, the establishment of facilities to encourage both recirculation of fit currency and repatriation of old-series currency. The audit plan that we have used in this study takes account of all of the available information and understanding that the Treasury and Federal Reserve possess concerning overseas counterfeiting and currency holdings. Following the Congressional mandate, it is based on three components: Models of U.S. currency usage overseas, models of counterfeiting abroad, and information obtained from country surveys with cash handlers and others knowledgeable about the extent of currency usage and counterfeiting issues abroad.

8.1 Overseas Currency Holdings

For some time, U.S. dollars have been the currency of choice internationally. In countries with underdeveloped banking sectors and unstable currencies, U.S. dollars are held in cash as a store of value, are used for transactions, and act as the unit of account, especially for larger transactions. Although dollars flow into countries when the domestic currency becomes very unstable or political crisis looms, they do not necessarily flow out when the crisis passes. Even in some countries with developed banking sectors and stable currencies, dollars are the preferred currency for travelers, for cross-border trade, for settlement of large cash transactions, and for transactions in the informal or gray sector.

The Federal Reserve supplies currency on demand and implicitly accommodates new demands that originate anywhere in the world. Various procedures developed by Federal Reserve staff suggest that about $250 to $350 billion of the $500 billion in banknotes in circulation are held overseas. Although the circumstances in each country are unique, demand for U.S. dollars (or indeed any other currency that circulates widely outside its home country) during a crisis does follow certain patterns. In a simple model of this process, the demand for the foreign currency (dollars) depends on the volatility of inflation and the differential between the inflation rate in the United States and the developing country. The degree to which a country becomes dollarized and the degree to

which residents desire cash dollars rather than dollar-denominated bank accounts depends on confidence in the domestic banking system. The quantity of cash dollars demanded also depends on a country's experience with dollars in the past and its economic circumstances.

Although estimates about overseas currency holding are necessarily imprecise, a confidence interval estimate in the neighborhood of $250 to $350 billion brackets most of the direct and indirect information we have on such holdings. To go the next step and try to attach numbers to individual countries or to regions is considerably more difficult. For one thing, most currency held outside the United States is used for transactions so it is in constant circulation and as a consequence repeatedly moves across various borders. While the Federal Reserve data and CMIRs provide information on shipments to and from various countries and the United States, there is no information about currency movements between other countries, nor is there reliable information about smaller quantities of currency leaving the United States or moving outside of wholesale channels. Our best guess is that about 20 percent each of overseas holdings are in the Western Hemisphere, the Far East, and in the Middle East and Africa. The remaining 40 percent is in Europe, including the former Soviet Union and some of its trading partners such as Turkey.

8.2 Overseas Counterfeiting

Given that so much genuine U.S. currency is overseas, how much counterfeit U.S. currency is also abroad? Numerous news reports in the mid-1990s suggested that vast quantities of counterfeit dollars might be circulating overseas. Inside the fifty states and territories, the Secret Service has jurisdiction over counterfeiting cases, and information about counterfeiting is routinely channeled to the Secret Service. Outside the United States, however, the Secret Service has no jurisdiction over counterfeiting cases involving U.S. currency. Further, information and procedures invoked when counterfeit notes are found overseas vary widely.

During the visits to the different countries, the level of concern about counterfeiting varied, but banks and other financial institutions detected one or only a few counterfeit notes of every 10,000 notes they processed. Outside the United States, in FY

1998 the Secret Service reported the seizure of $80.6 million, the suppression of twenty-nine counterfeit plants, and the passing of $3.2 million in counterfeit U.S. currency. This discrepancy between the passed and seized figures overseas reflects in part the fact that data on counterfeit U.S. notes passed overseas are inherently partial: The Secret Service's knowledge about counterfeiting of U.S. dollars is more complete in countries where they have better ties with local law enforcement agencies.

While counterfeiting rates are currently relatively low, it does not follow that one should be sanguine about the future. The nature of counterfeiting appears to be moving from an activity involving offset printing to one involving computers and attached printers, for which prices are falling and technology and accessibility are rising. For example, of the counterfeit currency printing operations suppressed inside the United States during FY 1998, 88 percent were produced by inkjet printers, a phenomenal increase from the FY 1995 figure of 19 percent. While the inkjet phenomenon is only beginning to register internationally, there is every reason to believe that it will spread abroad. Given these technology changes, concomitant improvements in both banknotes and Secret Service procedures are needed merely to stay ahead of the advancing counterfeiting threats. In addition, improvements in Secret Service capabilities are necessary, including more field offices and improvements in the traditional methods of record keeping. In terms of the former, the Secret Service has increased foreign offices and task forces significantly since the ICAP trips began in 1994. On the latter, the Secret Service has recently developed two new systems to improve statistical reporting: The Counterfeit Contraband System and the Counterfeit Note Search Site on the Internet.

8.3 Currency Distribution and Education Campaign

Historically, new BEP notes have been attractive to the international market for one reason: Their newness guarantees they are counterfeit-free. The 1996-Series Currency Introduction Plan provided for the establishment of an Extended Custodial Inventory Pilot program to facilitate the introduction of the new design currency, expedite the repatriation of the old design banknotes, and promote the recirculation of fit new design currency. In addition, the ECI program was to facilitate information flows about the circulation of both genuine and counterfeit currency. Both of these goals have

been realized: Currency circulation and redistribution have become more efficient, and the European and Asian ECIs have already also become an important direct source of information on external counterfeiting, as the Secret Service receives information directly from ECI operators regarding counterfeit notes detected during their verification process.

In addition, the ECIs provide a natural safety valve to deal with potential increases in currency demand related to concern about the century date change. By stockpiling U.S. currency inventories in strategic international distribution centers, banks and currency dealers overseas have an assured, immediate supply of U.S. currency to meet banknote demands resulting from financial or political disturbances and to mitigate financial panics.

The Department of the Treasury and the Federal Reserve have a duty to inform and educate all users of U.S. currency about prospective changes to the currency, including policies with regard to the treatment of older-series notes. In general, the worldwide education program has been successful in disseminating information about currency changes and must be continued.

8.4 Conclusions and Recommendations

There are five main conclusions. First, the audit program of the Treasury and the Federal Reserve has been successful in establishing new sources of information on the use and circulation of genuine and counterfeit U.S. banknotes abroad. Relationships have been developed with the banknote trading and law enforcement communities, allowing the Federal Reserve and the Secret Service to work more effectively in the international arena. The Federal Reserve and Treasury expect these benefits to grow as the program continues.

Second, the ECIs have worked well in providing more up-to-date information on overseas counterfeiting threats and encouraging the repatriation of old design notes. Thus, the ECIs should be extended and expanded.

Third, due to the success of the new-design note in deterring counterfeiting, more aggressive strategies that will foster the repatriation of old design notes should be considered.

Fourth, the Secret Service has obtained valuable information through the audit program, and will continue to draw upon information arising from the audits to evaluate its international strategy**.**

Finally, the public education campaign did contribute to the smooth reception of the new design 1996-series notes. Dissemination of information on any future new currency design should reach the international markets well before the new notes do. In particular, additional emphasis should be placed on future public education campaigns to ensure early delivery of training and educational material for both cash handlers and the general public. For the introduction of the remaining 1996 currency series, the international emphasis should be placed on those regions where lower denominations of U.S. currency ($10 and $5 notes) predominate, for example, Latin America and the Caribbean.

Appendix A

Methods for Estimating the Stock of U.S. Currency Held Abroad

A.1.1 The Seasonal Method

The seasonal method, as well as various other indirect methods discussed in Porter and Judson (April and October 1996), is based on the idea that U.S. currency held abroad is used differently from U.S. currency held at home in some measurable respect. The average measured characteristic of currency, say X, will be a weighted average of the characteristic for the domestically held currency, X^d, and of that for the foreign-held currency, X^f, as follows:

$$(1)\quad X = \beta X^d + (1-\beta) X^f$$

where the weight β is the domestic share of total currency outstanding, and $1-\beta$ is the foreign share. By observing the overall behavior of currency wherever it is located, we know X. We exploit various data to infer X^d or X^f, thus allowing an estimate of the shares of currency held at home (β) and abroad ($1-\beta$). The seasonal method uses relative seasonal variations in the currency circulating in the United States and Canada to infer overseas holdings of dollars. Four assumptions underlie this method:

- The seasonal pattern in domestic demand for U.S. dollars is similar to the seasonal pattern of demand within Canada for Canadian dollars
- Foreign demand for U.S. dollars has no significant seasonal pattern
- The circulation of Canadian dollars outside of Canada is negligible, so that the demand for Canadian dollars can be attributed solely to domestic demand
- U.S. currency is not used to a substantial degree inside Canada.

Under these assumptions, the share of U.S. currency abroad can be deduced by comparing the seasonality of Canadian currency in circulation to the seasonality of all U.S. currency in circulation. If foreign holdings exhibit seasonality similar to that of

domestic holdings, the estimate generally provides a lower bound on the share of currency held abroad.

A.1.1.1 Seasonality in Currency Holdings and in Banking Shipments

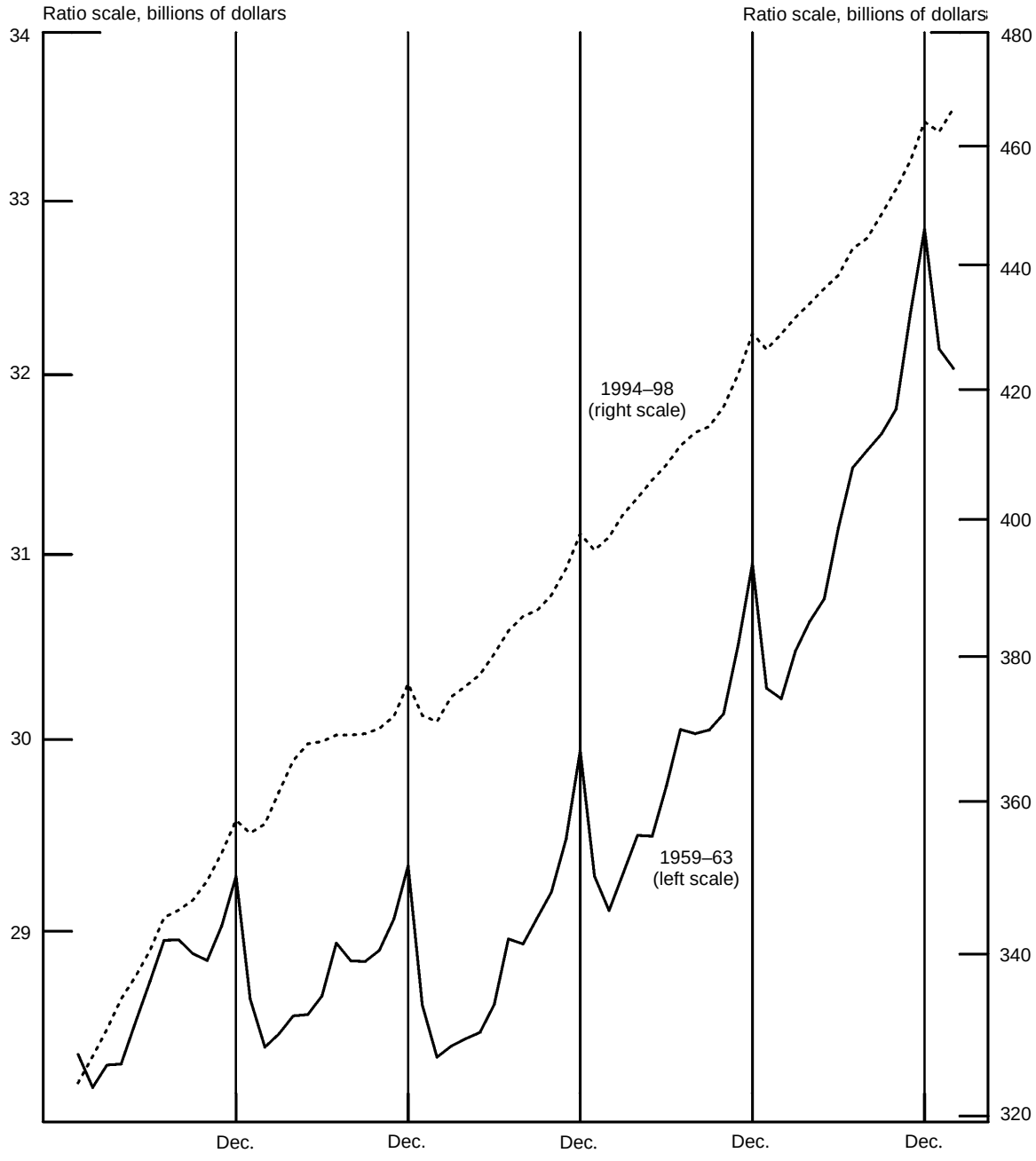
One factor undercutting any seasonality in foreign holdings is the unpredictable timing of foreign national crises, which tend to precipitate large dollar inflows to the affected nation. In addition, transaction costs may discourage foreign users from returning to the United States those dollars received in routine exchanges that may have a seasonal pattern. If foreign currency holdings have relatively little seasonality and have tended to increase relative to domestic holdings, then overall seasonal variations in U.S. currency holdings should have diminished. Strong support for such a hypothesis comes from a comparison of the seasonal variations in the currency component of M1 for the five-year periods at the beginning and end of the sample. The seasonal fluctuations for the last five-year period are much fainter and sharply reduced from what they had been in the first five-year period (figure A.1).[46]

A.1.1.2 Canada as the Benchmark for U.S. Domestic Behavior

Canada is a suitable benchmark for comparison for two basic reasons. First, Canadian currency is not used outside of Canada to any significant degree. Second, because the United States and Canada have a similar set of major holidays and school vacations and share many customs, the seasonal variations in retail sales and in consumption in the two countries are similar; hence the induced domestic demand for their respective currencies should also have about the same seasonal pattern. This similarity implies that any difference between the seasonal variation in total demand for U.S. currency and that for Canadian currency likely reflects foreign demand for U.S. currency. In addition, Canada's set of denominations is similar to that in the United States, and the bilateral exchange rate is sufficiently close to 1 that pairwise comparisons of individual denominations or combinations of denominations in the two currencies can be considered.

[46] The results are plotted through February of the next year, i.e. February 1994 and February 1999. This selection displays the full range of seasonal variation around year-end.

Figure A.1
Stock of U.S. Currency in Two Periods, not seasonally adjusted



A.1.1.3 The Seasonal Variation Technique

Typically, the currency component of M1 is seasonally adjusted with a model in which the unadjusted series is viewed as a product of three terms: A trend-cycle term, a seasonal term, and an irregular, or noise, term. The seasonal term in the unadjusted series (the reciprocal of the seasonal factor) is around 1 in periods without a discernible seasonal influence; it registers its largest values above 1 in periods of significant seasonal increases of currency, which occur around Christmas and the summertime vacation period; and it is typically the furthest below 1 after such periods, when the seasonal term typically declines sharply. Given the assumptions above, the model for the domestic and foreign holdings of currency can be written as follows. First, overall currency holdings can be modeled as the product of a trend-cycle (and irregular) component and a seasonal component in the respective (domestic and foreign) locations. In symbols let S be the seasonal term and T be the trend term so that

$$(1.1)\quad T_t S_t = T_t^d S_t^d + T_t^f S_t^f$$

where the superscript *d* is associated with the multiplicative currency components held domestically, the superscript *f* is associated with those components held outside the country, and the subscript *t* denotes time. The left side of equation 1.1 represents the overall unadjusted currency series as the product of the trend-cycle and seasonal terms, while the right side displays a parallel decomposition for the domestic and foreign components. If we let β_t be the fraction of the overall trend held domestically, and $1-\beta_t$ the fraction held abroad, then equation 1.1 can be rewritten as

$$(1.2)\quad T_t S_t = \beta_t T_t S_t^d + (1-\beta_t) T_t S_t^f$$

Canceling T_t from both sides of equation 1.2,

(1.3) $S_t = \beta_t S_t^d + (1-\beta_t) S_t^f$

Observe that equation 1.3 is an example of equation 1, with the seasonal term playing the role of the X variable in that definitional equation. Finally, assuming that the foreign seasonal component is always equal to 1 (that is, foreign demand does not vary seasonally), we can simplify equation 1.3 slightly:

(1.4) $S_t = \beta_t S_t^d + (1-\beta_t)$

Given values for the seasonal terms, equation 1.4 becomes a single equation in one unknown, β_t. We can solve for β_t provided that the seasonal terms in equation 1.4 do not equal 1. In periods without a seasonal influence (which is when $S_t = 1$ and $S_t^d = 1$), any value of β_t is consistent with equation 1.4, so we cannot identify a unique value for β_t. Thus, the method is capable of generating sensible estimates at some frequencies (including the annual frequency) but not at all frequencies.

The best estimate of the model is obtained by measuring the seasonal variation around Christmas, specifically from the seasonal high that is reached in currency in December to the seasonal low in February. This period of the year is the one in which the seasonal variation in currency is best aligned with the seasonal variation in transactions (retail sales). Formally, we take equation 1.4 and rewrite the time subscript *t* as *m*,*y* (where *m* refers to the *m*th month in the *y*th year) and set β_t to β. Then subtracting equation 1.4 for February from equation 1.4 for the preceding December and collecting terms in β, we find that the share of currency held domestically is

(1.5) $$\beta = \frac{(S_{dec,y} - S_{feb,y+1})}{(S^d{}_{dec,y} - S^d{}_{feb,y+1})}$$

To calculate this equation with actual values, we assume, for the reasons given above, that Canadian data can be used to estimate what the relative seasonal variations in the United States would be without any foreign holdings of currency. Given a seasonal adjustment procedure, we can use the estimate of the overall seasonal component for each of the denominations that use banknotes exclusively in the two countries, namely $5s, $10s, $20s, $50s and $100s. We use the banknote figures for the United States to estimate the numerator in equation 1.5 and use the analogous term for Canada to estimate the denominator; with the value for β, the domestic share, the share held abroad is then calculated as $1-\beta$.[47]

A.1.2 The Biometric Method

For any geographic area, the total population of notes to be estimated, *N*, can be expressed in relation to three known numbers: *M*, the total number of marked notes; *n*, the number of notes in a sample; and *m*, the number of marked notes in a sample. Assuming that the notes circulate freely and randomly, so that the sampled proportions of marked notes are representative of the notes circulating in the area chosen, Petersen's approach (Porter and Judson, October 1996, note 22) tells us that the sample proportion of marked notes is equal to the proportion of marked notes in the whole population:

$$(1.1)\ \frac{M}{N}=\frac{m}{n}$$

With the total number of notes in the population, N, in some geographic area (for example, a Federal Reserve Cash Office's area) as the only unknown in this relationship, we can solve for it as

$$(1.2)\ N=\frac{n}{m}M$$

[47]The irregular term in the seasonal decomposition can be viewed as being confined within the trend term. Adding an explicit irregular term does not alter the results.

We have used the Petersen method to obtain estimates of Federal Reserve 1990-series $100 and $50 notes circulating in the United States and abroad ($50s with the embedded security thread were introduced in 1992). We know the total number of marked notes, *M*, from outflows of the 1990-series $100s and $50s from each of the Federal Reserve Cash Offices; and we know the ratio of total sampled notes to marked sampled notes, *n/m*, from notes that are received from circulation at each Cash Office.

Because almost all currency sent to and received from foreign countries goes through the New York City Cash Office, we provisionally assume that this office is the foreign pool and the rest of the offices together constitute the domestic pool. We estimate total notes in circulation throughout the United States excluding New York City, say N_{xny}, by applying equation 1.2 to the pool consisting of all the offices outside New York City. Then, to obtain an estimate of total domestic currency circulation (that is, including New York City), N_d, we scale up to account for the population served by the New York City Cash Office:

$$N_d = N_{xny}(1 + pop_{ny} / pop_{xny})$$

where pop_{ny} is the population served by the New York City Office, and pop_{xny} is the population served by the rest of the Cash Offices combined.

We can estimate the foreign share of currency holdings in two different ways, depending on whether total notes are determined as the sum of the notes in all the Federal Reserve Districts, say

$$\hat{N} = N_{ny} + N_{xny}$$

That is, we either use an estimated number of notes ($\hat{N}$) or we can condition on the actual total of notes in circulation, say N . Unlike the biologists, we do know N , apart from what has been lost or destroyed.[48] Using $\hat{N}$, the estimate for total notes, we

[48] A difference between this problem and the biometricians' is that they capture and count marked species over discrete time intervals, whereas the Federal Reserve continuously processes currency. Thus, our

calculate the number of notes held in the United States as N_d, and the share of notes abroad is just $N_f = \hat{N} - N_d$. This method has the advantage of using parallel estimates for domestic and foreign circulation. Using the actual N, the share of currency abroad is estimated as N_f / N, which has the advantage of using our knowledge of the total amount of currency in circulation for each of the denominations.

Table A.1.2
Biometric Estimates of Currency Held Abroad
End-of-year figures, percent

Year	Type of notes used as "marked"	$50s		$100s	
		Value used for total stock of notes			
		Estimated	Actual	Estimated	Actual
1997	1996 only	60.6	75.2	59.2	76.2
	1990 and 1996	44.6	47.8	73.0	77.0
1998	1996 only	23.3	64.1	58.7	74.1
	1990 and 1996	45.5	48.4	72.7	77.4

The range of estimates for each denomination (see table A.1.2) can be considered outer bounds for the true figures because of the way they represent hoarded notes. The biometric method is able to estimate only the population of notes actively in circulation; the bank notes that are hoarded do not circulate and hence cannot be part of the estimates of *n/m* for any location. When the foreign share is estimated as the ratio of notes circulating in the foreign pool to all notes outstanding, the implicit assumption is that all uncounted notes are in the domestic pool, which is presumably not true; thus, the estimate is a lower bound of currency held abroad. Similarly, estimating the foreign share as the number of notes in the foreign pool over total measured notes implicitly assumes that notes are hoarded in the same proportion that they circulate. In this case, if notes are

computations should, in principle, use a lag of the quantity of new notes in circulation to account for the fact that notes released during the sample period are not actually part of the pool for the whole period. In practice, lags do not appear to matter. For estimates of notes that are lost and destroyed, see Laurent (1974).

hoarded disproportionately abroad, the estimate could be higher; however, the estimate for $100s is about 70 percent, and we find it unlikely that more than 70 percent of the hoarded notes in the world are hoarded abroad. Thus, we consider this estimate an upper bound.[49]

[49]The estimates appear to be relatively robust to alternative assumptions about the location of the foreign pool. Little changes if, as part of the foreign pool, we include two other cities, Los Angeles and Miami, that are believed to have significant foreign currency activity. Generally, if we try to align the District biometric estimates with the relevant economic variables that influence domestic currency location, we obtain estimates of domestic holdings that are similar to the aggregate biometric estimates.

Appendix B

Hoarding, the Likelihood of Pools of Counterfeits, and the Longevity of Counterfeits

This appendix considers the speed with which currency and counterfeits circulate when they are actively used in transactions as well as when they are held as a store of value for long stretches of time or are hoarded. In the first section of the appendix, a review of Federal Reserve cash processing data, survey data, and statistical models indicates that a substantial share of the stock of currency in circulation is hoarded for long periods of time both within and outside the United States. Since counterfeit currency generally circulates along with genuine currency, the hoarding phenomenon for genuine currency carries over *pari passu* to counterfeit currency.

A claim is periodically made that large isolated pools of dollars with high concentrations of counterfeits exist in various places outside the United States. Interviews with many banks indicate that the existence of such pools is highly unlikely, and the logic and data to bolster this conclusion are presented in section B.2. The third section takes another approach to determining the stock of counterfeits, calculating it as a function of the number of counterfeits found in a given year and the average life of a counterfeit note. Here again the existence of hoarded notes is an important factor in reconciling all of the relevant information.

The focus throughout the appendix is on $100 notes. As in the Lengwiler (1997) model, counterfeiters have an incentive to focus their efforts on important targets like the $100 U.S. note because it gives them a higher return than other denominations or currencies. In addition, the ICAP trips and other information indicate that $100s are used as a store of wealth in many parts of the world, including the United States, as much as they are used as a medium of exchange. To the extent that they are a store of wealth, $100s are less likely than other notes to circulate, and this characteristic will increase the time it will take before counterfeit $100s are detected in bank deposits.

This report supports the idea that the worldwide capability to detect counterfeit currency remains high. The model developed below in sections B.1 and B.3 provides a

complementary estimate of the amount of global and domestic counterfeiting based on the length of life of a note (its longevity) for counterfeit and genuine notes. The estimates made by this approach buttress the size estimates in Chapter 7. Nonetheless, the Secret Service does take issue with the model in one respect: It does not believe that the upper limits of the length of life for counterfeit notes as determined by this model are representative of the information that it has on such note lives based on its investigative field reports. These reports indicate that counterfeits do not survive for very long in circulation, presumably for the reasons described in B.2. This interpretation is consistent with the Secret Service's belief that the vast majority of counterfeit notes are detected and removed from circulation within a matter of a relatively few transactions. While the model in B.1 and B.3 is compatible with this possibility, the overall life of an average counterfeit note in the estimated model is significantly longer than these investigative field reports would indicate. Thus, while the Secret Service acknowledges that some pockets of hoarding do exist, it believes that the models laid out in B.1 and B.3 overestimate the extent to which hoarding affects the overall longevity of counterfeit notes.[50]

B.1 Hoarding

Both anecdotal and formal data indicate that substantial hoarding of currency takes place, even in the United States. Much more is known about domestic hoarding because data from surveys, anecdotes, and Federal Reserve cash processing activity can be combined. For foreign hoarding, however, cash processing activity and some simple models also yield some insights. We estimate that, worldwide, about 40 percent of all U.S. banknotes might be hoarded at any one time.

It is important to note at this point that the concept of "hoarding" is a slippery one. Few banknotes are held forever, but many are held longer than a week or two, which

[50]Further work would be required to reconcile the differences on the average longevity of counterfeit notes between that in the Secret Service reports and the estimates in the longevity model. In essence, reconciliation would require that the longevity model be modified to allow for either differences in the proportions of hoarded and actively circulating notes or for differences in the time spent in a hoard in the counterfeit population from that in the genuine population. Put simply, the longevity model bases its estimates in large part on the behavior of the genuine note population that the Secret Service believes is not indicative of that for the counterfeit note population.

is the typical length of time that banknotes used in transactions are held. Here "hoarding" applies to all notes held for saving. The issue of the length of time a banknote might be hoarded is addressed toward the end of the section.

B.1.1 Domestic Hoarding

Anecdotal, survey, and cash processing evidence strongly suggests that currency is hoarded, or held as a means of saving outside the banking system, within the United States and, thus, that the rate of overall currency circulation is slower than might be expected.[51] Anecdotal evidence emerges whenever a work stoppage (or other disruption of income flows) lasts long enough for individuals to start drawing on their accumulated savings, which may include cash held at home. At such times, older-vintage notes commonly reappear in active circulation.

Comparing survey data to currency stocks show that much more currency is in circulation than is held for everyday use. Assuming that only one-third of all currency is held within the United States, the domestic stock in March 1999 was $575 per capita. In contrast, survey respondents report holdings of around $100 per capita, or less than one-fifth the level of currency in circulation.[52] The surveys further indicate that currency turns over about 40 times per year, or about once every nine days. This rate is sufficient for $575 per person to finance $23,000 per year in expenditures ($\$575 \times 40 = \$23{,}000$), or around $2,000 more than total per capita expenditures for the survey. Since survey evidence suggests that only about 20 percent of expenditures are made with currency as opposed to checks and credit cards, an average turnover rate of 8 times per year rather than 40 would be more consistent with the evidence.[53] Most of the dollar volume of transactions in the United States is in $20s, and $100s last about four times as long as $20s, which implies that the speed of circulation of $100s is probably about one-fourth

[51]For discussions of hoarding, see, for example, Akerlof and Milbourne (1978), Boeschoten and Fase (1992), Dotsey (1988), and Selden (1902).

[52]A large part of the $475 per person difference is likely held as a form of tax evasion, though some other portion might be held just as a precaution for emergencies. Currency pays no interest, but its liquidity is unmatched. This store-of-value motive and not money laundering (associated with drugs and other similar crimes) is the typical explanation economists give to the relatively high amounts of currency per capita found in the United States and Western Europe.

[53]Porter and Judson (April 1996, table 1, line 10).

that of $20s.[54] Thus, the survey data for transactions, most of which is in $20s, combined with cash processing data on the relative lifetimes of $20s and $100s suggest that the annual turnover rate for $100s ought to be in the neighborhood of 2 rather than 40.

For $100s circulating in the United States, Federal Reserve cash processing statistics are consistent with a turnover rate of 2 times per year. Domestically held $100s are processed by the Federal Reserve an average of 1.38 times per year. Although notes also turn over outside the Federal Reserve, current practice in the banking industry is to return currency to Federal Reserve Banks rapidly. Under ordinary circumstances, valuables handlers (e.g., Brinks and Wells Fargo), acting as agents of a bank, pick up the cash from the various retail outlets that have commercial accounts with the bank and deposit the cash at a Federal Reserve office. Thus, the annual turnover rate for $100s outside banks is not likely to be much higher than the 1.38 observed at the Federal Reserve, and it is very unlikely that it exceeds 2 or 3.

B.1.2 Statistical Models of Hoarding

We present two statistical models of hoarding: The first uses only the data discussed in the previous section, and the second exploits the fact that a new-design $100 note was introduced in 1991.

For the first approach, we investigate a broad array of outcomes involving the fraction of hoarded notes and the circulation times for both hoarded and actively circulating notes. Let β be the fraction of actively circulating notes and $1-\beta$ the fraction of hoarded notes. The distribution of actively circulating and hoarded notes could follow a distribution such as the bell-shaped normal curve, but for simplicity, let us assume that each of these distributions is concentrated at one point, the first passage time, which is the average time it takes for the note to first reach the Federal Reserve after entering general circulation. Table B.1 gives the combinations of hoarded and actively circulating notes, and the average first-passage times in months before they reach the Federal Reserve, that are consistent with the observed first-passage time of 8.7 months

[54]See, for example, table 8 of Parke and Gillis (1991).

Table B.1
Combinations of First-Passage Times for Actively Circulating and Hoarded Notes Consistent with the Observed Turnover of $100s

Cash in active circulation (percent)	Interval before hoarded notes reach Federal Reserve (months)	Interval before actively circulating notes reach Federal Reserve (months)
4	9	1.5
5	9	3
6	9	4
20	10	3.5
23	11	1
25	10	4.8
25	11	1.8
26	10	5
30	12	1
33	12	2
43	13	3
44	12	4.5
45	15	1
50	12	5.4
50	13	4.4
50	14	3.4
50	15	2.4
50	16	1.4
53	14	4
60	15	4.5
60	18	2.5
60	21	0.5
62	18	3
63	15	5
65	23	1
68	24	1.5
70	22	3
75	21	4.6
75	24	3.6
75	27	2.6
75	30	1.6
75	33	0.6
76	22	4.5
78	36	1
81	33	3
84	36	3.5
85	41	3
90	42	5

(corresponding to the turnover rate of 1.38 per year). The points are computed for several thousand combinations of first-passage times for actively circulating and hoarded notes. These combinations cover a range of 0.5 month to 5.5 months in 0.1 month increments, for a total of 51 values for actively circulating notes, and from 6 months to 48 months by 1 month increments for a total of 43 values for hoarded notes.

Given these alternative first-passage times for each kind of note, and assuming that β ranges from 0.00 to 1.0 in increments of 0.01 (101 distinct points in all), the total number of different possible outcomes is more than 220,000. Of these, about 3.8 percent (35 out of 221,493) had first passage times of 8.7 months (table B.1). For example, if $\beta = 0.45$, which corresponds to the assumption that 45 percent of the notes are in active circulation, the hoarded notes have a first-passage time of 15 months and the circulating note has a first-passage time of 1 month: $8.7 = 0.45 \times 1 + 0.55 \times 15$.

The results naturally embody a trade-off between the speed of circulation for hoarded and actively circulating notes, with one increasing as the other decreases. This point is clearly seen by holding β fixed, as happens for 4 values of β (25, 50, 60, and 75), each of which has multiple combinations of hoarded and active circulation first-passage times that equal these particular values of β. For example, when β equals 50 percent, the hoarded times increase from 12 months to 16 months as the active circulation times decrease from 5.4 months to 1.4 months. Each of the 38 combinations in the table generates the observed turnover rate, so without other information on the process, we can not discriminate more finely among the most likely possibilities. A value of around 60 percent for β aligns these results with those from the second hoarding model, which we consider next.

In the second model, a share, h, of the currency stock is hoarded in a given year, and a share, α, of the hoarded stock is turned over every year. The currency processed is a random sample of the active notes only. The key ingredient in this model is that a new-design $100 note was introduced in 1991. After this date, all old-series $100s arriving at Cash Offices were replaced with new-series $100s. We have eight years of data (1991–98), and two unknowns, h and α. If the population of notes is n and notes are drawn (processed) randomly with replacement, then the probability that a note gets processed in one draw is $1/n$. The probability that a note is drawn after n draws is thus

$$1 - \left(1 - \frac{1}{n}\right)^{p}$$

The only notes that can be processed are in the active share of the pool, *A*. Since the draws are independent, the number of notes replaced, say, *r*, is just equal to *An* times the probability that one note will be replaced:

$$r = An\left(1 - \left(1 - \frac{1}{n}\right)^{p}\right)$$

Dividing both sides by *n* and denoting time-varying variables with the subscript *t* we obtain our basic equation, in which *R*, the share of notes replaced, is a function of *A*, the active share of the population; of *n*, the total note population; and of *p*, the number of notes processed:

$$R_t = A\left(1 - \left(1 - \frac{1}{n_t}\,\frac{1}{A}\right)^{p_t}\right)$$

The stock of $100s outstanding grew fairly rapidly in this period. We assume, however, that the *share* of notes hoarded remained constant. After the first year, *R* is defined as a value net of note growth. Moreover, one must account for the fact that some notes enter the active pool and some leave. If α is the share of inactive notes that re-enter the active pool each period, *R* after the first period is defined as

$$R_{t>1} \equiv (I - Gn_t)m^{-a}$$

where *I* is the number of new notes issued, *G* is the growth rate of the stock of notes, and m^{a} and m^{h} are active and hoarded stocks of new-series notes respectively, with m^{a} defined as follows:

$$m_t^a = m_t - m_t^h \equiv m_t - \left((m_{t-1}^h - \alpha m_{t-1}^h + \alpha(1+G)A^{-1}(m_t / n_t) \right)$$

Given the two parameters, we conduct a grid search to find the best fit. We estimate the parameters separately for notes circulating within and outside the United States. We do not know the total number of notes circulating in each area, so we estimate the parameters for a range of assumptions about the share of notes held abroad. As in previous work (Porter and Judson, April and October 1996), we treated the New York Cash Office as the "foreign" office since we know that it handles the bulk of foreign shipments.

The objective functions are well behaved but fairly flat. In general, they indicate that hoarding is unlikely to be important for very long, and that turnover is likely to be high. For example, for the case in which 50 percent of currency stocks are assumed to be abroad, we find that α, the turnover rate for inactive currency, is 0.6 for domestic currency and 0.99 (corner solution) for overseas dollars. We find that the share hoarded is 0.19 at home and is effectively zero (again a corner solution) overseas.[55] For other assumptions, the highest share of hoarding found is 0.69, and the lowest turnover is 0.47. We conclude that large quantities of notes are highly unlikely to stay out of circulation (and hidden from counterfeit detection) for very long.

Given these estimates, and if we assume that the turnover rate is 0.6 for domestic notes and that it holds over time, we find as a consequence that the implied lifetime of a hoarded note is about 18 months. In terms of table B.1, this age estimate implies that about 60 percent of the notes are in active circulation and that the average lifetime of an actively circulating $100 note is 2½ months to 3 months, the shaded entries in this table.[56]

[55]It might seem counterintuitive that overseas notes emerge from the hoarding state more readily than domestic notes. A 1989 survey of notes circulating domestically and internationally found that foreign and domestic notes had similar age and degree-of-use profiles. Such a pattern indicates that the notes were active to about the same degree both domestically and overseas. Since currently a large portion of U.S. currency is held abroad in rather undeveloped economies where currency is used extensively, the turnover rate may be higher abroad simply because currency is a relatively more important source of payment there than in the United States.

[56]Two other assumptions are embedded in this estimate. We assume that once a hoarded note re-enters circulation, its active lifetime is 1 month. Second, a hoarded note that enters circulation in the first year has a lifetime of 9 months, midway between its minimal life in the hoard of 6 months and the highest possible estimate.

B.2 Isolated Pools of Currency

The logic behind the conclusion in section 7.4.2 of the main text—that notes cannot remain in circulation for relatively long periods—is readily laid out. Since most transactions are between unrelated individuals, the assumption that successive transactions are statistically independent from each other is plausible. To make the analysis tractable, we also assume a constant, low probability that after any transaction, a given banknote will remain outside the financial sector. After all, apart from transactions between individuals, most currency transactions are with retail establishments, and most retailers generally deposit or sell all but "seed" cash—in particular, all large-denomination notes—at financial institutions or exchange houses on at least a daily basis.

Survey evidence suggests that currency actively circulating both within and outside the United States turns over (is exchanged) on average about once a week.[57] If the note is used in one transaction per week, and successive transactions are independent, the probability, *p*, that the note will continue to recirculate after *w* weeks has a joint binomial distribution with probability p^w. Thus, the complementary event that a given note is returned to a financial institution after w transactions is $1-p^w$.

This result would be the end of the story if financial institutions were always successful in detecting counterfeits, but they are not. Hence, we need to allow for the possibility that a counterfeit will be mistakenly accepted in a deposit. Let ω be the probability that the financial institution correctly removes the counterfeit from circulation, with $1-\omega$ being the probability that it fails to remove it. From data on the prevalence of counterfeits in deposits at the Federal Reserve we will estimate ω empirically. Given these assumptions, the probability that a note circulate for *w* weeks and then be successfully removed from circulation is $(1-p^w)\omega$.

From the form of this function we see that, unless the detection capabilities in the banking system are poor, $(1-p^w)\omega$ will approach ω after a relatively short time. Although ω is strictly less than 1, it is close to 1, so the rough probability that the note

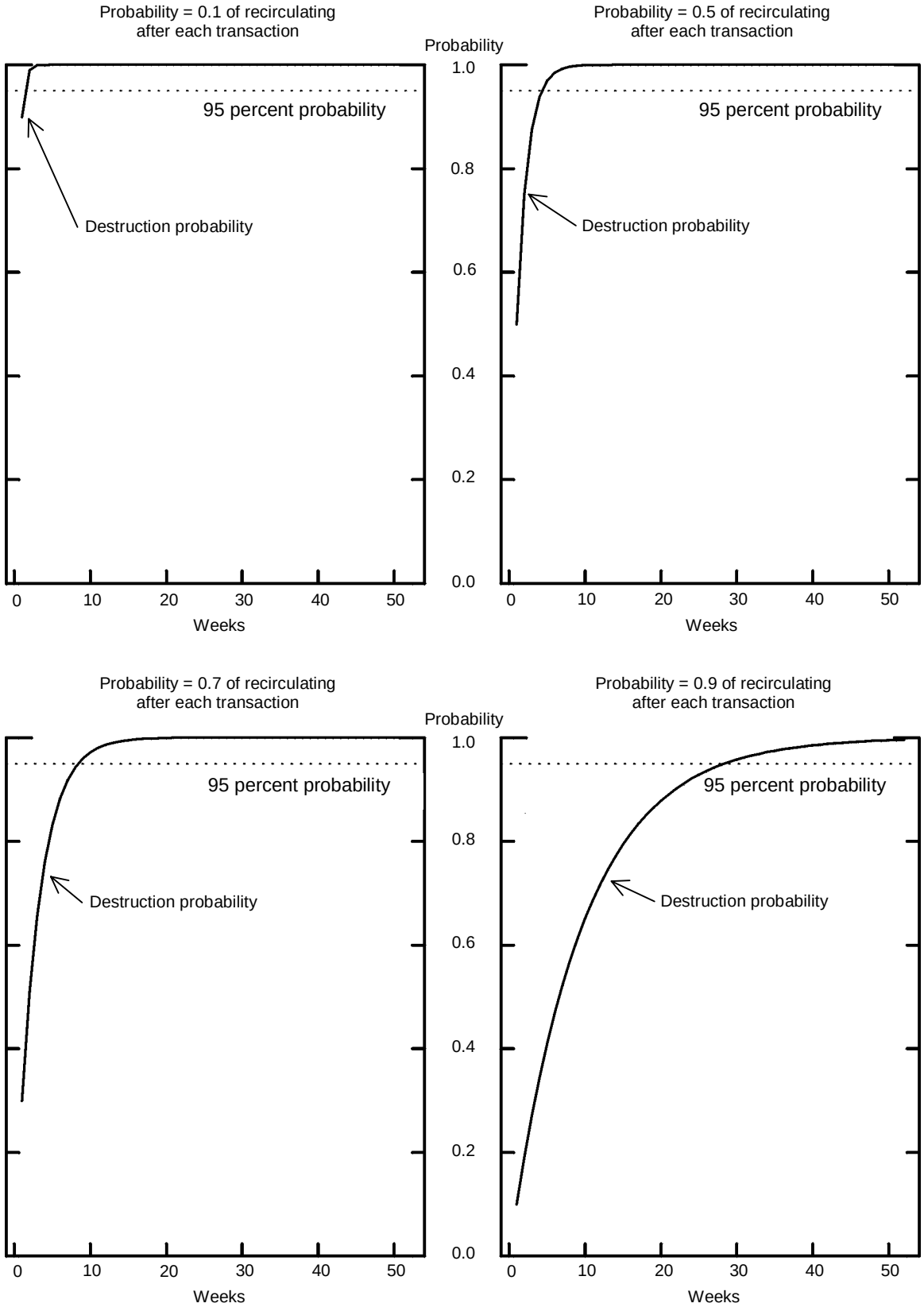
[57] See Porter and Judson (1996) and Feige (1996).

will be detected approaches 1. This result holds even if p is close to unity because it is always less than 1 and is raised to the power w (see figure B.1). For example, consider the extreme case in which p is high, say, 0.9 (figure B.1, bottom right panel), in which case the odds are 9 to 1 that a note will recirculate. Even in this case, the probability is greater than ½ that after 7 weeks the note will hit the banking system; and the probability is greater than 0.95 that after 29 weeks the note will stop recirculating.[58] A more plausible assumption would be to assume that $p = 0.1$, so that most transactions are with retail vendors and not with "hand-to-hand transactors." In this case, the probability that the note will be returned to a financial institution approaches 1 almost immediately (figure B.1, top left panel). These values tend to bolster our assumption that counterfeit notes in active circulation are likely to move out of circulation relatively quickly. Even if we relax the assumption about how often $100s turn over, from every week to a slower pace of every month, the results would still hold if we simply put a new label on the horizontal axis of months, not weeks. In that case, and given 50-50 odds that a note would go to a financial institution, the probability that the counterfeit would be detected by the fifth month would rise above 0.95 (figure B.1, top right panel).

If notes turn over more frequently than once per week, the time elapsed during the first passage to a financial institution would be even shorter. In some countries, cash dollars are the dominant medium of exchange, even for small daily purchases. In this case, notes could turn over as fast as once per day on average, and if they did, the 29 weeks for the first passage of a note to a financial institution (in the extreme case, with

[58]The point at which the curve (for p = 0.9) intersects the horizontal line with the probability equal 0.95. Of course, if enough banks were lax and returned counterfeits to depositors, the longevity of a counterfeit would be extended. Because we can not rule out such dereliction in some places, even if it is typically discouraged, we must acknowledge the possibility that notes could circulate longer before being destroyed. In this case, however, the proper classification of the note may become somewhat unclear if the note is generally recognized as a counterfeit. In the limit, the note would be better placed among the seized class and not the passed class of notes if the note fools no one.

Figure B.1
Note Longevity



p = 0.9) would be cut to 1/7 of the time, or a little over 4 weeks. Conversely, if notes turn over more slowly on average because of hoarding, it will take more time for a counterfeit note to reach the banking system.

Once currency hits the banking system, it naturally flows to regional financial processing centers and is routinely repatriated in large quantities. Thus, currency does not generally recirculate in large amounts, most probably not in amounts any greater than is found in Federal Reserve deposits from foreign sources. Further, it is quite unlikely that banks recirculate counterfeits either to other banks or to their customers. While the bank pays no additional penalty if another bank or the Federal Reserve finds a counterfeit, its reputation can suffer if customers find the bank giving out counterfeits. In sum, we find it unlikely that counterfeits can circulate for long outside the banking system and thus outside reasonably sophisticated counterfeit detection—for no more than a year in the extreme cases in which the notes are held as a store of wealth.

B.3 A Model of the Amount of Counterfeits Based on the Longevity of Notes

The analysis in section 7.3 of the main text relies on the rates at which counterfeits are found in currency deposits at Federal Reserve Banks. Implicit in this analysis is the treatment of the longevity of a counterfeit. Here we present a complementary analysis of the counterfeiting problem that explicitly takes into account the length of life of a counterfeit note.

To see why the longevity of counterfeits affects the analysis of counterfeiting statistics, consider an extreme case in which a single counterfeit is in circulation at all times, with a new note produced each day to replace the single note that is confiscated each day. In a 365-day year, 365 counterfeits would be found, but the stock of counterfeits circulating at any time would be just 1. Thus, the number of counterfeits found in a year (in the example, 365) multiplied by their longevity in years (in the example, 1/365) gives the correct estimate of the stock of counterfeits circulating at any time. Put another way, if counterfeits are continually created but have a lifespan of only a few days, the stock of counterfeits in circulation will necessarily be a small fraction of the

total that are captured in a given year. In short, we need to examine the longevity of counterfeits in one way or another to properly estimate the amount in circulation.

Counterfeits, like genuine notes, are quite likely to reach Federal Reserve Cash Offices within a few transactions. In that context, counterfeit notes are detected rapidly. However, this observation by itself does not imply that the average counterfeit note *in circulation* has a lifetime of only a few weeks or days. The lifetime of the *average* note will be a weighted average of the lifetime of an actively circulating counterfeit and the average lifetime of a hoarded counterfeit, where the weights are the relative shares of counterfeits in each category. [59] As noted above, the share of notes held as hoards kept out of active circulation is probably substantial, and thus the average life of a counterfeit is heavily influenced by the length of time the average hoarded note stays out of active circulation. .

In fact, Federal Reserve cash processing data can help resolve this issue. Assume first that the stock of counterfeits in circulation as a share of genuine currency in circulation is roughly constant. Then the number of counterfeits that are detected and removed from circulation each year should be roughly equal to the number that are placed into circulation. The findings on the longevity of counterfeit $100s are consistent with data on the longevity of genuine notes. Table B.2 lays out the possibilities, with the longevity of counterfeit notes ranging from 1 month to 12 months and the amount of $100s held domestically ranging from 60 percent down to 30 percent (and the corresponding foreign percentage ranging from 40 percent up to 70 percent).[60] The analysis in section B.2 suggests that a typical counterfeit that circulates will likely be detected in most instances in a matter of, say 12 weeks (3 months), a period comparable to that which the Secret Service believes to be the longevity of lower-quality counterfeits. But evidence from a small sample of data on certain relatively rare, high-quality counterfeits ("super notes") indicates that such notes might be able to circulate for a

[59]We are implicitly assuming that the relative proportions of hoarded and actively circulating notes is the same as that of genuine notes. Such a symmetry assumption is the simplest assumption that we can make and appears consistent with the available evidence.

[60]The Federal Reserve's estimates for $100s are all much closer to a 70 percent or even 75 percent share abroad, but we include this broader range to indicate the possibilities.

Table B.2

Estimated Stock of $100 Counterfeits For Various Longevity and Share Abroad Assumptions

Longevity	Implied counterfeits in U.S. (millions of dollars)	Share of genuine notes in U.S. (percent)	Implied counterfeits abroad (millions of dollars)	Implied total counterfeits (millions of dollars)	Implied value per 10,000 $100s in circulation
1 month	2.2	60	1.5	3.7	.1
		30	5.2	7.4	.2
3 months	6.6	60	4.4	11.0	.3
		30	15.5	22.1	.7
6 months	13.2	60	8.8	22.1	.7
		30	30.9	44.2	1.4
12 months	26.5	60	17.7	44.2	1.4
		30	61.8	88.3	2.8

Note: $100s outstanding: $320.1 billion (December 1998); counterfeit $100s passed in 1998: $26.5 million.

considerably longer period than the typical counterfeit, about 3½ years. But supernotes constitute perhaps about 3½ percent of all counterfeit $100s that are passed. Thus, if we assume that the lower-quality counterfeits last 3 months and the higher-quality counterfeits last 3½ years, the average lifespan of a counterfeit $100 would increase 1½ months, to 4½ months.[61] Thus, in the table B.2, we consider 4½ months and a 30 percent domestic share as the most plausible estimate. This assumption about longevity and share abroad corresponds to a total worldwide stock of counterfeits of about $33 million, or about 1 in 10,000 genuine notes, the normal level for all notes in circulation.[62] This figure falls in the lower end of the range set out in section 7.3.2, where the estimate was $50 million and the range was $15 million to $100 million.

Genuine notes circulate, return to Reserve Banks, and sometimes recirculate; their average lifespan is about 8 years.[63] In contrast, counterfeits end their lives when they are

[61]That is, if rare counterfeits lasted 3½ years and the others lasted 3 months, the average lifespan would be $0.035 \times 3.5 + 0.965 \times 0.25 = 0.367$ per year, or 4 to 5 months.

[62]The calculations for counterfeits found domestically were done separately from those found in foreign locations. However, the differences were so small that we need report only the combined estimate.

[63]The estimate is probably on the high side. A 1989 survey found such an estimate, but the rate at which $100s have been received from circulation has increased significantly since then, suggesting an average age more in the neighborhood of 5½ years. The eight-year life does not take into account "forced death,"

detected, which, at the very latest, is on their first (and only) trip to a Federal Reserve Cash Office. Cash processing data from the first year following the introduction of the 1996-series $100 note indicate that about one-third of the total notes outstanding at the beginning of the period were replaced, which means that one-third of the notes reached the Federal Reserve at least once. If counterfeits circulate at least as fast as genuine notes, then, on average, counterfeits remain in circulation for at most about three years before being detected. However, notes within the United States return to Federal Reserve Cash Offices more frequently than notes outside the country because of the higher cost of moving the overseas notes.[64]

Table B.3 shows the same figures as in table B.2, but for all denominations. For example, an estimated longevity of 3 months would imply a total amount of counterfeits in the world of between $16.6 million and $33.3 million. The stock of counterfeits estimated from a longevity of 6 months and a foreign share of all U.S. currency at 70 percent—$66.5 million—is very close to the estimate in section 7.3.3 of $70 million to $75 million. Similarly, our upper bound of one year and $133 million is very close to the earlier upper-bound estimate of $140 million, and our lower-bound estimate of $25 million suggests a longevity of 2 months to 3 months.

The result might seem to contradict the fact that lower-denomination notes circulate more rapidly than higher-denomination notes. But overseas, lower-denomination notes reach financial institutions less frequently than others and tend to be less carefully inspected for counterfeits. Such notes represent only about 10 percent of the notes handled by wholesale banks, and it takes longer for a sufficient number to accumulate before they can be repatriated. As a result, lower-denomination counterfeit notes tend to be detected later.

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which occurs when the Federal Reserve wants to encourage users to remove older series notes from circulation sooner, as it has for the pre-1990 and pre-1996-series notes recently.

[64]While we cannot cite life cycles for specific notes, we do have evidence from the recent Treasury trips, for example, that new $100 notes paid out from the New York Bank in April 1996 were deposited at the Los Angeles branch of the San Francisco Bank, through Hong Kong in less than 6 weeks, and were still in pristine condition. Research conducted in 1989 with notes circulating inside and outside the United States suggested that the circulation rates outside of the United States were the same as those inside.

Table B.3

Estimated Stocks of Counterfeits For Various Assumptions about Longevity and Share Abroad

Longevity	Implied counterfeits in U.S. (millions of dollars)	Share of genuine notes in U.S. (percent)	Implied counterfeits abroad (millions of dollars)	Implied total counterfeits (millions of dollars)	Implied rate per 10,000 notes of counterfeits
1 month	3.3	60	2.2	5.5	.1
		30	7.8	11.1	.2
3 months	10.0	60	6.7	16.6	.3
		30	23.3	33.3	.7
6 months	20.0	60	13.3	33.3	.7
		30	46.6	66.5	1.9
12 months	39.9	60	26.6	66.5	1.4
		30	93.1	133.0	2.7

Note: Total stock of all denominations: $492.2 billion (December 1998); counterfeits detected: $39.9 million passed within the United States.

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