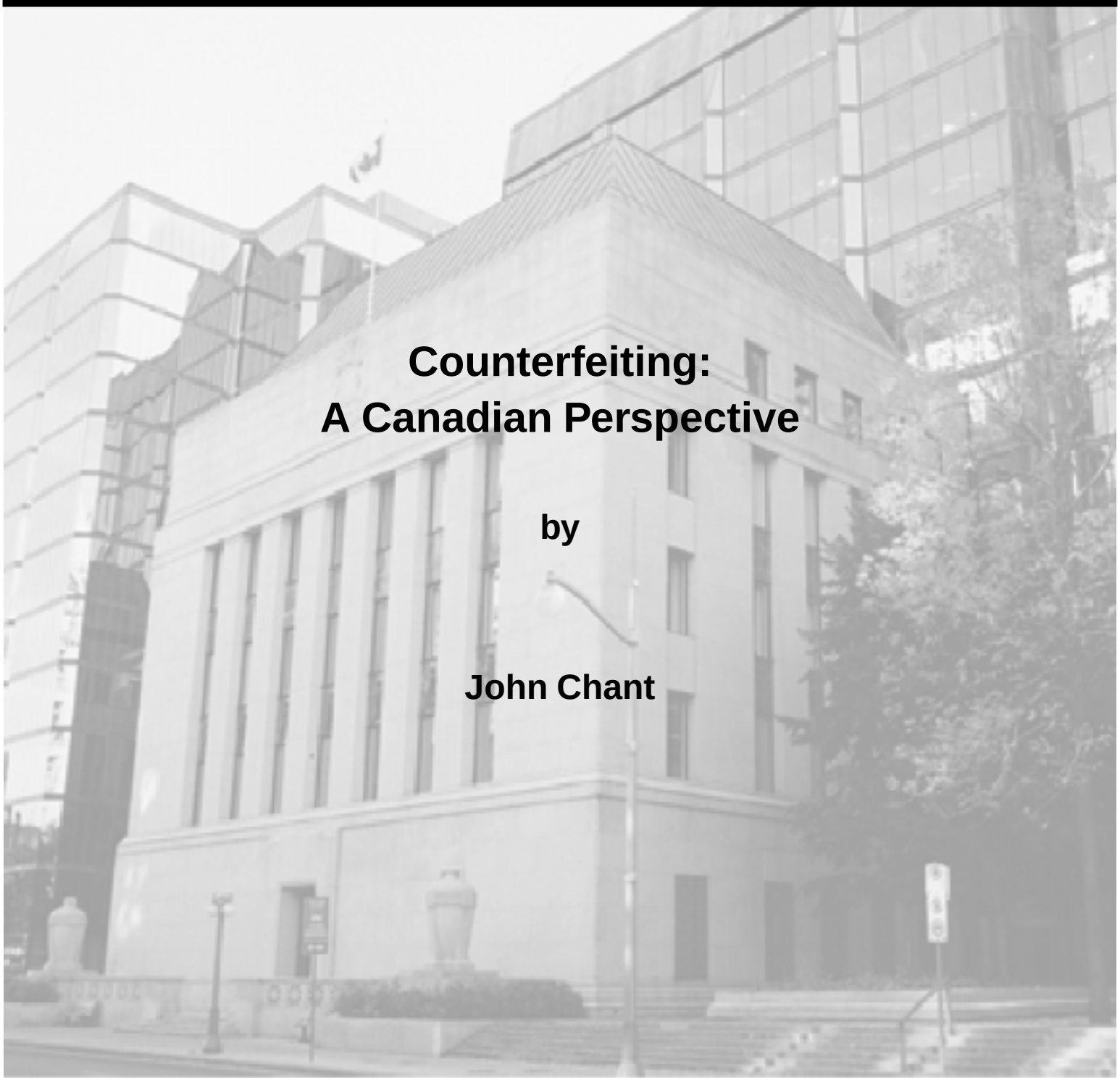
Bank of Canada Banque du Canada

Working Paper 2004-33 / Document de travail 2004-33



Counterfeiting: A Canadian Perspective

by

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ISSN 1192-5434

Printed in Canada on recycled paper

Bank of Canada Working Paper 2004-33

September 2004

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Acknowledgements

John Chant was Special Adviser at the Bank from September 2001 to August 2002. He is indebted to David Amirault, Ron Bodkin, Sarah Church, Paul De Swart, Pierre Duguay, Dan Dupuis, Clyde Goodlet, David Longworth, John MacKenzie, Kim McPhail, Bill Murphy, Robert Opini, James Powell, Jim Reain, Nick Rowe, Bonnie Schwab, Varya Taylor, and Lorna Thomas for their comments, help, and encouragement.

Abstract

Counterfeiting is a significant public policy issue, because paper money, despite rumours of its demise, remains an important part of our payments system. Various parties have a stake in the prevention of counterfeiting. For individuals and businesses, the share of counterfeits in outstanding currency indicates the likelihood that the next bill they receive will be counterfeit. For government, it indicates the extent to which the circulation of counterfeits displaces legitimate currency and reduces its seigniorage benefit from the right to issue currency. Most significantly for monetary authorities, it indicates the degree to which counterfeiting challenges the integrity of the nation's currency. The author considers the economic issues that counterfeiting raises. He proposes an innovative method for estimating the quantity of counterfeit currency in circulation and develops estimates for Canada for 2001. Such a measure can make a significant contribution to public policy by providing a basis, through international comparisons, for assessing the effectiveness of different currency features in combatting counterfeiting.

JEL classification: E5, E58
Bank classification: Bank notes

Résumé

La contrefaçon constitue un problème majeur pour les pouvoirs publics parce que, en dépit des bruits courant sur sa disparition éventuelle, le papier-monnaie demeure une composante importante de notre système de paiement. Un grand nombre d'agents économiques ont intérêt à ce que l'on fasse échec à la contrefaçon. Pour les particuliers et les entreprises, la proportion de faux par rapport à l'ensemble des billets en circulation indique la probabilité que le prochain billet reçu soit un faux. Pour le gouvernement, elle reflète la mesure dans laquelle les faux billets se substituent aux billets authentiques et réduisent les revenus de seigneuriage découlant du privilège d'émission. Fait particulièrement important pour les autorités monétaires, cette proportion donne une idée de la mesure dans laquelle la contrefaçon remet en cause l'intégrité de la monnaie nationale. L'auteur examine les problèmes économiques que soulève la contrefaçon. Il propose une nouvelle méthode d'estimation de la quantité de faux billets en circulation et présente des estimations du degré de contrefaçon au Canada en 2001. Du fait qu'elle permet d'effectuer des comparaisons internationales pour juger de l'efficacité des éléments de sécurité intégrés aux billets de banque, cette mesure peut apporter une contribution appréciable à la politique des pouvoirs publics en matière de lutte à la contrefaçon.

Classification JEL: E5, E58
Classification de la Banque: Billets de banque

Goal: To create a currency that the government can produce in the billions and no one else can produce once.

T.A. Ferguson
Director
U.S. Bureau of Engraving and Printing

June 2002

1. Introduction

Even though it is not the most lurid of crimes, counterfeiting seems to fascinate the public and the press. The media have recently focused attention on reports of counterfeiting activity in Canada. Surprisingly, economists have shown little interest in studying the issue.[1]

Counterfeiting is a significant public policy issue because paper money, despite rumours of its demise, is still an important part of our payments system. Table 1 shows that almost $36 billion in notes was outstanding on average during 2001. Over 50 per cent of these notes consisted of $20 bills (excluding $1, $2, and $1,000 notes), with the remainder spread fairly evenly among the other denominations. Canadian individuals and businesses held almost 1 billion notes (excluding $1, $2, and $1,000 notes), or approximately 32 notes per person. These holdings represented over $1,053 in notes per capita, of which over 49 per cent consisted of $100 notes.

The role of currency in total payments is difficult to estimate because of the lack of information about the value of payments made using currency. Bank credit cards and debit cards may appear to be taking over the traditional role of currency in small payments. Despite the rapid growth of these payment technologies, Canada's $36 billion of circulating paper currency needs to turn over just six times per year to carry out the $216 billion worth of transactions performed in 2001 with credit and debit cards combined.[2]

Several parties have a stake in the prevention of counterfeiting. The public, especially those handling currency payments, want to know their chances of receiving a bogus bill in any transaction. Central banks, as currency issuers, want to know the degree to which their currency has been corrupted by counterfeits. Counterfeits represent a financial loss to

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1. A search of *Econlit* (an index of published papers in economics) using the word "counterfeit," turned up many references to the counterfeiting of luxury brand goods. The use of "counterfeit" and "currency" yielded only three academic references.
2. All these payment methods—currency, credit cards, and debit cards— were dwarfed by the cheque payments system in 2001. Some 1.3 billion cheque transactions with a value of $4,265 billion were cleared through the Canadian Payments Association.

issuers of currency, and a sufficient level of counterfeits in circulation may jeopardize public acceptability of a currency issue.

A substantial loss of confidence in domestic currency may cause the public to turn to substitutes, a transition that could create a high level of uncertainty for individuals and businesses. Indeed, in times of war, the disruptive costs of such a drop in confidence can be used as a weapon. This was recognized by Galeazzo Sforza, a Milanese duke in the fifteenth century, in his efforts against enemies in the rival city-state of Venice and by the United States in the Vietnam War. Both attempted to sabotage their foes' economies by destabilizing their currencies through the wholesale introduction of counterfeit currency (Altig 2002). Indeed, the costs of the Nazi attempt to destabilize the British pound in World War II have been described as follows: "while less obviously violent than Luftwaffe bombs. . . recognized as no less virulent" with an objective "to undermine the public confidence in the pound and, by so doing, irreparably damage the British economy" (Altig 2002, 1). As history makes clear, the effort failed. But it did provide the Nazis with the resources to support their chain of subversive agents in Britain.

The current concern with counterfeiting raises a number of issues. Does the recent attention reflect changes in the significance of counterfeiting? What cost does counterfeiting impose on the economy? How important are counterfeits relative to our overall currency supply? What challenges does counterfeiting pose for policy-makers?

This paper seeks to redress the lack of attention given by economists to this issue by considering the economic issues raised by counterfeiting. To do so, an innovative method for estimating the quantity of counterfeit currency in circulation is proposed, and estimates are developed for Canada for 2001. This measure is vital for public policy with respect to counterfeiting. For individuals and businesses, the share of counterfeits in outstanding currency indicates the likelihood of receiving a counterfeit note. For government, it measures the extent to which the circulation of counterfeits displaces legitimate currency and reduces its seigniorage benefit from the right to issue currency. Most significantly, it allows monetary authorities to gauge the degree to which counterfeiting challenges the integrity of the nation's currency.

The paper is organized as follows. Section 2 describes the changes in technology that have increased the threat of counterfeiting; section 3 examines the economic costs of counterfeiting to society; section 4 discusses the usefulness of different measures of counterfeiting; and section 5 compares different methods for estimating counterfeit currency in circulation. Estimates of the current extent of counterfeiting of Canadian currency are discussed in section 6.

2. New Challenges from Counterfeiting

The history of counterfeiting is as old as money itself, and its evolution has followed that of money. The first commodity monies, such as gold and silver coins, tempted counterfeiters to find cheaper materials to replace those being used. The development of paper money made counterfeiting even more attractive by lowering the production costs to a fraction of the value in exchange. But not all changes in the evolution of money have encouraged counterfeiting. Some, such as the move away from many private currencies to one national currency, discouraged counterfeiting because the larger scale of production justified greater investment in security features.[3] The move to a national currency also meant that the public would need to be familiar with the features of only one currency issue to protect themselves from counterfeits.

For most of the twentieth century, counterfeiting was limited by the large investment needed for the engraved plates and offset presses required to produce copies of currency credible enough to be accepted. The introduction of sophisticated colour photocopiers and ink-jet printers in the early 1990s dramatically changed the technology of counterfeiting, and sharply lowered the costs.

Changing technology has also altered both the organization of counterfeiting and its vulnerability to detection. Offset printing required bulky equipment that was difficult to hide. Moreover, counterfeits were produced in substantial runs and stored before being placed

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3. The exploits of the Johnson gang in the 1880s illustrate the limited investment in security by some private issuers of bank notes. Speer recounts that the Johnson forgeries could be distinguished from authentic notes because they were “too perfect” and lacked the engraving flaws present in authentic notes (Speer 1904).

into circulation. Together, these features exposed counterfeiting operations to raids by enforcement authorities. With new ink-jet and photocopy techniques, counterfeits can be produced on demand, and thus no inventories are needed.

The effects of these technological changes have been reflected in a substantial increase in the value and volume of counterfeit recoveries shown in Table 2. The level of counterfeit recoveries has increased from 73,279 in 1993 to 137,045 in 2001. Changing technology has also been reflected in the patterns of recoveries. By 2000, photocopies and ink-jet-printed notes accounted for 98 per cent of all counterfeits detected.

The new technologies have also altered the way in which counterfeits are detected: there has been a marked shift in the pattern of detections away from uncirculated counterfeits towards counterfeits in circulation. As Table 2 shows, the share of counterfeits detected in circulation has increased steadily from 74 per cent in 1993 to 94 per cent in 2001.

3. The Economic Cost of Counterfeiting

Counterfeiting results in different types of costs:

- costs to currency holders
- costs to other users of currency
- revenue costs to the government

Each of these must be considered when examining the overall costs of counterfeiting to the economy.

3.1 Costs to currency holders

3.1.1 Losses from detection

The person who first accepts a counterfeit note from the forger is not necessarily the one who bears the loss. The real victim is the person who is holding the note when it is detected. This person exchanged goods and services for the note expecting that the note could be exchanged later for other goods and services. Victims of counterfeiting lose because they gave up goods and services and received nothing in return. This type of cost

from counterfeiting reached $6 million in 2001. These losses can be compared with the $142 million in credit card losses in the same year.[4] Economists note that these are so-called redistributive costs and are not a cost to the economy overall. The losses suffered by the public are matched by the gains of the counterfeiters.

3.1.2 Costs of prevention

Prevention costs for counterfeiting include public costs such as spending for police, the courts, and the prison system. They also include the costs borne by individuals and enterprises to protect themselves from counterfeiting. The prevention of other types of theft consists of locks and security systems, but counterfeit prevention involves training cash handlers to detect counterfeits and investing in counterfeit detectors. Unlike redistributive costs, prevention costs represent a loss to society as a whole: resources are directed from other uses to the prevention of counterfeiting. Moreover, these costs are likely to be a multiple of the direct losses suffered from counterfeiting if the public's response is similar to that for other crimes. Brantingham and Easton (1998) estimate that total costs to Canadians from property crimes in 1996 were $11.5 billion when prevention costs are taken into account, an amount 2.5 times the direct cost of property crimes.

Counterfeit prevention has an additional cost—the expense incurred by the Bank of Canada to provide a secure currency. This includes the added cost of incorporating security devices in currency issues (i.e., bank notes are more expensive than they would be in the absence of counterfeiting), together with the costs of designing new note series, which must be issued more frequently in face of the threat of counterfeiting.

In the absence of counterfeiting, the Bank would face "normal" expenses for issuing currency. The above-normal expenses caused by counterfeiting are incurred for all the currency that the Bank of Canada issues. If extra security features were added as a result of

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4. Source: The Canadian Bankers Association, Fast Stats. Although credit cards may be used for more transactions than currency, the losses on credit cards were 22 times the losses from counterfeiting. The $36 billion currency stock would need to turn over only 3 1/2 times a year to carry out the same value of transactions as credit cards. Nevertheless, the losses from counterfeits may be more apparent because they are borne by the retailers who are stuck with the worthless notes. Losses from credit cards are usually passed on by financial institutions in banking fees rather than charged directly against victimized retailers or cardholders.

the current levels of counterfeiting (129,000 notes detected in 2001), they would be required on all outstanding notes of the same denomination. The addition of a security device with a cost of two cents per note would eventually require a continuing expenditure of $6 million per year to incorporate the device in replacement notes for those retired because of wear. The cost would increase substantially with a more rapid introduction of the device, because new notes would be needed to replace existing currency that was not worn out.

3.2 Costs to other users of currency

3.2.1 Inflation costs

The price level of any economy is determined partly by the amount of money "chasing" the supply of goods. As long as it is undetected, counterfeit money has the same effect on prices as authentic currency: it raises the price level. This reduces the purchasing power of legitimate money, causing losses to its holders because their money buys less. This effect will be small because currency is only a small part of the money supply, and changes in its quantity are unlikely to significantly affect the price level. Indeed, the effect will not be present in countries that pursue inflation targeting. In these cases, the inflationary impact of counterfeit currency is offset by a reduced issue of authentic currency.

3.2.2 Costs from reduced use of currency

Currency is useful only as long as people have confidence in its value in transactions. It may be surprising to learn that the Bank of Canada and other central banks are not pledged to convert currency into some form of backing, such as gold. The currency part of our payments system works because people give up valuable goods and services for "coloured pieces of paper" (bank notes) because they believe that they, in turn, can use these pieces of paper to obtain goods and services. Confidence could be lost in a specific denomination or in the currency as a whole if people feared counterfeiting to a sufficient degree.

Losing confidence in a specific denomination would not be as costly as losing confidence in the entire currency, because people could switch to notes of other denominations. For example, people could use $20s and $50s if confidence in $100 notes were lost. Neverthe-

less, a cost remains, because each denomination is particularly suited to specific types of transactions. For example, $5 notes are not convenient to pay for intercity air travel, whereas $100 notes are not useful for purchasing newspapers. In fact, the pattern of outstanding currency largely reflects the suitability of different denominations for particular transactions.[5]

A shift away from a particular denomination would also impose costs on the Bank of Canada as currency issuer. Because the Bank meets the public's demand for specific denominations, notes of the threatened denomination would be returned to the Bank prematurely and replaced with notes of other denominations. To the extent that the threatened notes are replaced by those of a lower denomination, the Bank's costs would rise. If, for example, people choose to use $20 notes rather than $100 notes, the Bank will have to produce five times as many notes to meet the public's need for currency.[6]

Recent experience with the $100 note suggests that even low levels of counterfeiting can threaten the acceptance of a specific denomination. During 2001, just 46,649 counterfeit $100 notes were detected relative to an outstanding stock of just over 160 million notes. Thus, fewer than three counterfeits were detected for each 10,000 authentic $100 notes in circulation. Even this low level of counterfeiting provoked as many as 15 per cent of merchants in some areas to refuse to accept $100 bills.

It is difficult to estimate the cost to an individual when a particular denomination is refused. But the loss of confidence in one denomination may spread to others, particularly when the security features are the same. The costs will then be more significant. In the extreme, the loss of confidence from a high level of counterfeiting may cause people to stop using currency and turn to other means of payment (barter, foreign currencies, cheques, credit or debit cards, etc.) that are more expensive or less convenient to use for particular transactions. Those who do not switch initially suffer because they have fewer

5. See Tschoegl (1997) for a discussion and references to the literature.
6. Similarly, the costs to the Bank would rise if a note that is more expensive to produce replaced the threatened bill.

partners with whom they can use currency and, as a result, they will be more likely to switch.[7] If this continues, the currency will eventually become useless.[8]

Perception, as distinct from reality, can be important in determining whether a currency retains the public's confidence. The fact that some retailers refuse to accept a particular denomination has a demonstration effect. Other retailers, even if they have no experience with counterfeits themselves, may choose to refuse this denomination. In addition, customers may choose not to use that denomination, not because they fear counterfeits, but because they fear that the notes will not be accepted when they want to make purchases.

There is limited experience with respect to the point at which confidence in a currency is lost, especially under current conditions when the threat from inexpensive technologies, such as sophisticated photocopiers, is so new. Experience with inflation suggests that currency is so useful that people continue to use it even when inflation imposes high costs. The parallel between inflation and counterfeiting is not exact, however. The costs of inflation are spread across all holders of currency (and other forms of money), whereas the costs of counterfeiting tend to be disproportionately concentrated on merchants, especially fast-food outlets and convenience stores, where currency is the predominant type of payment.

It is difficult to estimate the costs to society as a whole from the loss of a national currency for making payments. Such a loss would affect everyone in the economy in terms of the time and effort, together with extra monetary costs, needed to make payments by other means. In this case, even a small cost per person has substantial consequences, given that virtually everyone uses currency.

The extreme case of a loss of confidence in all the notes of a particular issue of a country's

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7. Currency is what economists describe as a network utility in that each user's benefit depends on the number of other users with whom exchange is possible.

8. Nosal and Wallace (2001) develop a model that suggests that counterfeiting may preclude the possibility of a monetary equilibrium. This result confirms that counterfeiting is a serious threat that warrants substantial preventive action, even though its occurrence in practice may be low.

currency, although unlikely, would require its replacement. One possibility is that the domestic currency is replaced by a foreign currency. Even if this could be an orderly process at the hand-to-hand currency level, costly adjustments would be required in the restatement of the accounts of financial institutions and other financial contracts into the substitute currency. Alternatively, the domestic currency could be replaced by other methods of payment, such as cheques and debit cards. In this case, the costs would be less, since the currency could still be used as the unit of account. Progress in the adoption and development of alternative payment technologies, such as debit cards, may alleviate the consequences of reduced confidence in a currency.

3.3 Revenue costs to the government

Governments receive revenue from the circulation of currency. In Canada, the central bank holds government securities against its outstanding issue of currency and, in 2001, received $2.1 billion in interest revenue from these securities. A small part of these revenues is used to finance the Bank of Canada's operations, and the remainder is transferred to the Government of Canada each year. This revenue would shrink to the extent that people reduced their use of currency.

4. Dimensions of Counterfeiting

Various measures of counterfeiting can provide different perspectives for public policy. These measures include

- the flow of counterfeits detected over time,
- the rate at which counterfeits are detected in Bank of Canada processing,
- the stock of circulating counterfeits, and
- the introduction of counterfeits into circulation.

As shown in Table 3, each measure also has a different significance and availability.

4.1 Counterfeits detected

The number and value of counterfeits detected by denomination over any period are published monthly in the *Bank of Canada Banking and Financial Statistics*, a degree of disclosure that appears to be unique. The detection data have economic significance in that they indicate those losses realized by the public through the acceptance of counterfeit currency. But these costs are only a part of the economic cost of counterfeiting. This measure also provides an indication of the level of counterfeiting activity, albeit with an uncertain lag.

Despite any intuition to the contrary, the volume of detections over a period (a flow), will not be a good measure of outstanding counterfeits (a stock). As Table 4 shows, the same level of detection can be consistent with a large circulating stock with few detected over a period, or a small stock with a higher proportion detected.

4.2 Rate of detection in processing

The proportion of counterfeits—"parts per million"—measure of counterfeiting is determined during processing by the currency issuer. This could provide an accurate measure of the share of counterfeits in the stock of outstanding currency if all false notes were detected through processing. But this is not the case. Notes received for processing may have already been "handled" by others, such as retail cashiers, bank tellers, and the back-office employees at commercial banks, all of whom detect a share of the counterfeits.

The detection of counterfeits by the public rather than by the central bank is not the only problem with this measure of counterfeiting activity. Movements in this measure can take place for different reasons. Certainly, an increase in counterfeiting activity will soon be reflected in an elevated level of counterfeits detected during currency processing. But the proportion of counterfeits detected by the Bank also depends on the frequency with which currency is processed. For example, if currency is processed once a year on average, the Bank will detect those counterfeits placed into circulation over the past year that have not been discovered by the private sector. If processing occurs only once every two years, the share of counterfeits in the notes processed would be expected to be larger if

counterfeiting activity remained unchanged. It is important to recognize that a higher proportion of counterfeits in notes processed need not reflect a higher level of counterfeiting activity if the frequency of processing has changed. The decreased frequency of currency processing by the Bank of Canada since 1997 has been one factor contributing to a higher proportion of counterfeits detected during processing. It has also resulted in a higher volume of counterfeits in circulation (in the absence of any change in counterfeiting activity), because one source of detection has become less intensive.

4.3 Stock of circulating counterfeits

The circulating stock of counterfeit currency indicates the potential cost arising from a systemic threat to a currency. Unlike detections, the circulating stock imposes no costs on the public other than its impact on the purchasing power of legitimate currency or the loss of seigniorage to the currency issuer. Other than these relatively minor effects, it might be questioned whether undetected counterfeits impose costs. Can what people and the money issuer don't know hurt them? Any costs of undetected counterfeits are potential costs. But the hidden nature of undetected counterfeits could change quickly if a simple, cheap device could be discovered, possibly by accident, that could detect counterfeit notes.[9] Confidence in a particular denomination or a currency issue could be jeopardized if the stock of outstanding counterfeits were found to be large. Unlike the previous two measures, the stock of circulating counterfeits cannot be measured directly.

The stock of counterfeits outstanding at any time will be the result of several factors—the the level of counterfeits introduced into the system, as well as the length of time that they circulate, which depends partly on the frequency of the central bank's currency processing.

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9. Tom Ferguson, Director of the U.S. Bureau of Engraving and Printing, related how a simple protein detector was able to distinguish genuine U.S. currency from counterfeits. The detector left yellow marks on genuine bills because of their protein content. Not surprisingly, counterfeiters quickly countered by placing yellow marks on their notes to suggest that they had already passed the test. Still, this device altered the technology of counterfeit detection in a short period of time and revealed the extent of one type of counterfeiting (Ferguson 2002).

4.4 Introduction of new counterfeits

A measure of the introduction of new counterfeits into circulation would, if it existed, provide a valuable indicator of the future threat to the currency. While this measure is unknown at any time, some indicators may be available. Data with respect to police seizures of undistributed counterfeits provide some indication of current counterfeiting activity. This measure also depends on the resources committed to detection by the police and, in the short run, would be subject to fluctuations. This measure is less useful than in the past because changing technology has reduced the need for inventories of unissued counterfeits. The efficient use of offset techniques created runs of currency in excess of amounts that could be distributed immediately. Ink-jet printers and photocopiers do not have the same set-up costs and provide a more even flow of bogus notes.

5. Method of Estimation

The current stock of circulating counterfeits indicates the level of risk to the integrity of the currency and is a vital input for public policy regarding counterfeiting. Still, there is much uncertainty about the actual level of counterfeiting, and this leads to rumour and speculation. *The Economist* (2001) cites one forensic analyst who claims that as much as 2 to 3 per cent of the former euro-currencies and 30 per cent of U.S. dollars circulating in Russia, Eastern Europe, Africa, and elsewhere may be counterfeit. These levels for U.S. dollars contrast markedly with reports from the U.S. Secret Service that only $47 million in counterfeit notes was detected in the United States during 2001.[10] They are also inconsistent with the latest report by the U.S. Treasury Department (March 2003), which estimates the proportion of counterfeits in U.S currency outstanding as 1 in 10,000 notes worldwide.

In a rare attempt to measure the stock of circulating counterfeits, the U.S. Treasury used two approaches: the “parts-found-in-processing (PFP)” method and “the life-of-counterfeits (LOC)” method. The simplest PFP approach extrapolates the number of counterfeits

10. See also Judson and Porter (2003), who deal directly with the circulation of counterfeits outside the United States.

per million found by the monetary authorities during currency processing to the entire stock of currency. PFP' extends the approach to reflect the discovery of counterfeits outside the authorities' processing activities. In contrast, the LOC method extrapolates the flow of discovered counterfeits to the stock using estimates of the life of counterfeits in circulation.

In this section, these alternative approaches are reviewed and assessed. An alternative composite (COMP) approach is also proposed that overcomes some of the limitations of the PFP and LOC methods. Table 5 shows the data that form the basis for the different estimates.

5.1 Parts-found-in-processing approach

The simplest PFP approach estimates the number of circulating counterfeits of any denomination, C_N, as

$$C_N = BOCPPM \bullet NIC_N ,$$

where *BOCPPM* is the number of counterfeit notes detected per million notes processed by the central bank and NIC_N is the outstanding stock of notes of denomination *N*.

The PFP approach would measure the stock of counterfeits accurately if (i) detected counterfeits were found only during the central bank's processing activities, and (ii) the notes processed by the bank were representative of outstanding currency with respect to the share of counterfeits. In this case, the bank's detection rate for each denomination could be extrapolated to the stock of notes of that denomination to give an estimate of circulating counterfeits. Such estimates are presented in part A of Table 6.

One shortcoming of the PFP method is that it treats all counterfeits as if they were detected during processing by the monetary authority. As the U.S. Treasury recognizes, the conditions necessary for this simple extrapolation do not hold. The data on counterfeit recoveries in Canada (Table 2) show that recoveries by the general public have been substantial. Overall, the Bank of Canada accounted for only 21.5 per cent of total counterfeit detections in 2001, with the remainder made by the general public—individuals,

businesses, and financial institutions. The central bank's share of detections ranged from a high of 31.5 per cent for $10 notes (processed, on average, once a year) to a low of 10.4 per cent for $100 notes (processed, on average, once every 10 years). The private sector's contribution to the detection of a substantial share of the counterfeits recovered from circulation means that any estimates must reflect recoveries by both the public and the monetary authority.[11]

The U.S. Treasury has adapted the PFP approach to take into account detections made in the private sector. The adapted version of PFP (PFP') adds the proportion of counterfeits detected by the public to the proportion detected during processing by the monetary authority:

$$C_N = BOCPPM \bullet s \bullet NIC_N,$$

where s is the ratio of total detections to detections made by the central bank.[12] These estimates are shown in part B of Table 6.

Unfortunately, the adjustment used in the PFP' approach does not take into account the difference between the rate of currency turnover in the public's transactions and the rate at which it is processed. Therefore, the adjustment would be appropriate only if the monetary authority processed all currency each time it turned over in private sector transactions.[13]

These two PFP approaches, as the U.S.Treasury recognizes, set limits on the estimates by effectively bracketing the stock of circulating counterfeit notes. The PFP approach represents a lower-bound estimate because it does not include the counterfeits detected outside

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11. The Bank of Canada has recognized the importance of public detection, and this is reflected in its growing currency-education program.
12. More precisely, the ratio $s = TD_N/BD_N = (PD_N + BD_N)/BD_N$,
    where TD_N represents total detections of counterfeit notes of denomination N; PD_N, detections of denomination N made by the public; and BD_N, detections of denomination N made by the central bank in processing. *TD*, *PD*, and *BD* are all measured as number of detections per year.
13. This assumption would imply the following rates of turnover: $5—once a year, $1—once every 10 months, $20—once every 8 months, $50—once every 5 years, and $100— once every 10 years.

the central bank. The PFP' approach represents a useful upper-bound estimate because it is based on the implausible assumption about the turnover of currency in private transactions.

5.2 Life-of-counterfeit approach

The U.S. Treasury also estimates the stock of circulating counterfeits using the "life-of-counterfeit" (LOC) method. This method extrapolates the flow of discovered counterfeits to the total stock by using the estimated life of counterfeits. With this approach, the number of circulating counterfeits of denomination *N is*

$$C_N = LOC_N \cdot TD_N,$$

where LOC_N represents the life of counterfeits, and TD_N is the annual recovery of counterfeits of denomination *N*. The shortcomings of the LOC approach are more practical than those of the PFP approach: data on the circulating life of counterfeits are meagre. Estimates derived from the LOC method, based on data on the life of counterfeit $100 notes, and then extrapolated to other denominations on the basis of the lives in circulation of authentic notes, are presented in part C of Table 6.

5.3 The composite method

The proposed composite method (COMP) combines elements of both PFP and LOC to estimate the stock of circulating counterfeits. It draws on the LOC approach by using rare data on the life of a particular run of $100 counterfeits to provide a basis for estimating the lifespan of counterfeit $100 notes. It then uses PFP, together with data on the public's detection of counterfeits, to anchor estimates of the counterfeit stock on assumptions about the public's efficiency in detecting counterfeits. The COMP method uses more data for its estimates than either the LOC and PFP approaches. These data include information about the life of counterfeits, the rate at which counterfeits are detected by the monetary authority during processing, and the annual flow of counterfeits detected outside the monetary authority.

This approach explicitly recognizes that screening for counterfeits takes place both inside

and outside the Bank of Canada. The public and financial institutions, in their transactions and processing of currency, are the sources of screening outside the monetary authority. The efficiency of screening when currency is transferred among individuals, businesses, and financial institutions indicates the proportion of counterfeits that originally existed in the batches of currency before they were sent to the central bank.

The COMP method estimates the stock of outstanding counterfeits using three separate elements.

(i) The first element expresses the relation between the stock of outstanding counterfeits, *C*, of any denomination, *N*, and detections of counterfeits of that denomination, given the assumed efficiency of public screening, *e*, and the proportion of counterfeiting detected by the central bank, *BOCPPM*:

$$C(e)_N = PPM \bullet NIC_N = BOCPPM \bullet NIC_N / (1 - e). \quad (1)$$

[14]

This relation states that any batch of currency in circulation has a proportion *PPM* of counterfeits. Any batch of currency processed by the central bank first turns over in a private sector transaction, where *e* of the counterfeits are detected before it is passed to the central bank, where the remaining counterfeit notes are detected. It builds on the PFP method by allowing for different efficiencies of public detection.[15] The extreme values of 0 and 1 for *e* are ruled out because the possibility that the public is unable to detect counterfeits contradicts the data showing that they do, and the possibility of a value of 1 contradicts the fact that some counterfeits are still found in the batches of currency that reach the Bank of Canada.

(ii) The second element deals with the turnover of currency needed to account for the actual level of public detection of counterfeits during a year, given the efficiency of public screening. It relates the estimated turnover, *T*, of counterfeits of denomination *N* to

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14. If *PPM* is the original proportion of counterfeits in circulating currency, then the proportion detected by the central bank *BOCPPM* = (1–*e*)*PPM*.
15. Equation (1) would be equivalent to the PFP method when *e*=0, and to the PFP' method when *e* = *PD/TD*.

the efficiency of public screening:

$$T(e)_N = PD_N / ePPM \bullet NIC_N , \qquad (2)$$

where the denominator measures public detections per turnover of the circulating stock of denomination *N*. From equation (2), *e* can be expressed as a function of turnover:

$$e = PD_N / (T(e)_N PPM \bullet NIC_N). \qquad (2a)$$

(iii) The third element relates LOC_N, the estimated life of counterfeit notes of denomination *N* to the stock of counterfeits of that denomination, C_N , and to the annual flow of detections, TD_N:

$$LOC_N = C(e)_N / TD_N. \qquad (3)$$

Equation (3) is a rearrangement of the basic LOC equation.

Data are readily available for *BOCPPM* in equation (1); all NIC_N in equations (1) and (2); and for all $T(e)_N$ in equation (2). Each equation, however, requires information on unknowns in order to estimate $C(e)_N$. These unknowns are *e* in equations (1) and (2); T_N in equation (2); and LOC_N in equation (3). Values for T_N and LOC_N could be derived using knowledge about the turnover rate of the currency or the life of counterfeits. In both cases, however, information is limited.

Estimates of the turnover rate of currency are few and are of questionable reliability. A survey conducted by the U.S. Treasury suggested that currency turns over about 40 times per year (U.S. Treasury 2000, 96). Households responding to the same survey reported holding only $100 in currency compared with the Treasury's estimate of $575 per household. In addition, as the Treasury pointed out, this turnover rate, together with the estimated $575 currency per capita, would finance $23,000 per year in expenditures, almost $2,000 more than the level reported in the survey. Based on survey responses indicating that households used currency in only 20 per cent of their transactions, the Treasury suggested that the turnover rate of currency is likely to be nearer to 8 times per year. While this rate may seem low, it is consistent with a large proportion of currency used as a store of value with a low velocity, or with a large portion of currency held by businesses and

used in intermediate, as well as final, purchases.

The composite method overcomes the limitations of the data by estimating the life of counterfeits needed in equation (3) using a unique set of data collected by the Bank of Canada and Canadian law-enforcement authorities. Specifically, the recoveries of a series of high-quality counterfeit $100 notes circulating in the late 1990s are used to estimate the life of counterfeits. As shown in Chart 1, these recoveries peaked in mid-1998 about the time that the counterfeiters responsible for the series were taken into custody, and declined steadily thereafter. The pattern is consistent with the gradual running down of a fixed stock of counterfeit notes that reached a maximum near the time of the arrests.

The average life of this series of counterfeits was estimated using the recovery data shown in Chart 1. The rate of decay of the stock of counterfeits was derived as follows. The stock of counterfeits at any time *t* periods after the series ceased to be introduced, $C_{t,}$ can be represented as

$$C_t = C_o e^{-dt}\,, \qquad (4)$$

where C_o is the stock at the time new counterfeits ceased to be introduced, and *d* is the rate of decay of the counterfeit stock. But since the rate of decay, $r_t = d\,C_t$,

$$r_{\,t} = r_0 e^{-dt}.$$

Thus, the decay rate of circulating counterfeits can be estimated by the equation

$$\ln r_t = \ln r_0 - dt\,.$$

Estimates of this equation for the series of counterfeit $100 notes over various periods, starting around the time of the arrest of the counterfeiters and ending in 2002, centred on a value for *d* of 0.08 per month, giving an average life of slightly more than 12 months.

When a value of 12 months is substituted for the life of $100 counterfeit notes in equation (3), an estimate of 48,518 outstanding $100 counterfeits is obtained (part C, Table 6). Further substitution into equation (1) yields an efficiency of public screening of $e = 0.1$, which implies a rate of 303 per million counterfeits among circulating $100 notes and an annual turnover rate of 6.7 for $100 notes.

The lack of data on the lifespan of other notes rules out using the same method for estimating counterfeits of other denominations. Instead, the estimates for the other denominations use the data in Table 5 with respect to the lifespans of different denominations of currency. These data, together with the assumption that turnover and currency life are inversely proportional, give estimates of the turnover rates for each denomination. The estimated turnover rates are substituted into equation (2) to give estimates of *e* for each denomination. These values for *e* are then substituted into equation (1) to give estimates of the number of $5, $10, $20, and $50 counterfeits in circulation in 2001, shown in part D of Table 6.

5.4 Sources of bias

The derivation of the COMP estimates is based on several assumptions:

- the lifespan of the identified series reflects the overall experience with counterfeit $100 notes
- the relation between the lifespan and turnover rate of notes of different denominations represents actual experience
- all counterfeits detected in circulation are reported in the Bank of Canada data
- notes processed by the Bank are representative of all notes outstanding in terms of proportion of counterfeits
- the Bank detects all counterfeits in the batches that it processes

5.4.1 Life of counterfeits

Counterfeit notes differ substantially in quality. Anecdotal evidence suggests that some counterfeits are so crude that they are detected immediately when passed into circulation. Others, such as the "supernote" U.S. $100 bill, are of such high quality that they are apparently difficult to detect.[16] Allowing for differences in quality would change both the analysis and the interpretation to be placed on the results.

The assumed lifespan of counterfeit notes, based on the experience with the identified $100 counterfeit series, provided the basis for the analysis. This series was not, however, a

16. The U.S. Treasury suggests that the life of "supernotes" may be as long as 3 1/2 years (U.S. Treasury 2000, 105–6).

typical counterfeit, either in terms of quality or the quantities placed into circulation. Its superior quality brought it to the attention of the authorities and led to it being designated a series. Moreover, it was produced in sufficient numbers that it accounted for 80 per cent of $100 counterfeits detected during 1999. Thus, it is likely that notes of this series remained in circulation longer than other, lower-quality counterfeits.

As discussed above, it is not possible to be completely sure that the counterfeit stopped flowing into circulation once production was halted. Consequently, estimates of the lifespan of counterfeits based on the data for the series may be atypically long. Both these features mean that extrapolations based on the survival of this series of counterfeit $100 notes may, if anything, overstate the estimates for outstanding counterfeits in general.

5.4.2 Turnover

The source of bias with respect to the relationship between turnover rate and currency life is more subtle. The relationship itself depends on the further assumption that currency wear depends solely on turnover and is otherwise independent of the time the currency has been in circulation.[17] The assumption that wear depends directly on time in circulation would lead to the overestimation of the turnover of other denominations if part of the wear of $100 bills were a function of their time in circulation and not their turnover. On the other hand, if people took greater care of higher-denomination notes so that their wear was lower relative to their turnover, the proportional relationship would underestimate the turnover of lower-denomination notes.

The estimated efficiency of public screening depends inversely on the estimated turnover, and the estimated counterfeits in circulation depend, in turn, directly on the efficiency of public screening. Thus, underestimates of turnover lead to higher estimates, and overestimates of turnover lead to lower estimates of circulating counterfeits. The effects of this bias on the estimates are then ambiguous: neither the size nor the direction of the bias can

17. Turnover refers to the number of times a note is transferred in making transactions. The life of a note refers to the time between a note being placed into circulation and the time that it leaves circulation. They are related in that notes with high turnover wear out more quickly, and, as a result, have a shorter life. The relationship is not perfect, however, because notes may be withdrawn before they are worn out.

be determined. Sensitivity tests, however, suggest that even substantial differences in turnover at values close to those estimated would not materially affect the estimates of circulating counterfeits.[18]

5.4.3 Reporting

The analysis also assumes that all counterfeit detections are included in Bank of Canada data; i.e., that in addition to detections by the Bank, they include those reported to the police by individuals and businesses. It is this last group that raises a possibility of bias. It is difficult to judge the extent to which victims of counterfeits report their discoveries. Many recipients of counterfeit $5 and $10 notes would just accept their losses. Most of the threat from counterfeiting, however, comes from higher denominations that tend to be of better quality and that are often detected when businesses process their cash or make deposits at banks. Counterfeits detected at these stages are more likely to be reported since businesses have an interest in preventing counterfeiting.

Under-reporting of counterfeits affects the estimation procedure in several ways. The time pattern of the recoveries of the identified series plays a role in the choice among alternative scenarios for the $100 note through matching the life of counterfeits implied in different scenarios with its average life. Constant under-reporting of the identified series would not, however, affect this rate of decay, since each reported recovery level would be a fixed fraction of actual recoveries.

5.4.4 Nature of screened notes

The Bank of Canada typically screens notes under two circumstances: (i) when financial institutions judge the notes to be worn and (ii) when a financial institution has notes in excess of its needs and the amount of non-circulating notes that it can store under its agreement with the Bank of Canada (Bilkes 1997). If these were the sole reasons for the Bank to process notes, the reported detection rates would be typical of the currency received by the Bank from financial institutions. Occasionally, however, the Bank recalls and processes currency from particular regions where it believes the incidence of counter-

18. For example, raising the assumed turnover of $20 bills by 10 per cent would raise the estimate of outstanding counterfeits by just 0.8 per cent.

feiting may be unusually high. If this assumption is correct, to the extent that the Bank processes currency on this basis, the Bank's reported detection rates would be higher than those for normal processing. This would also cause the estimates of circulating counterfeits to be biased upwards. The use of targeted processing is quite recent and was small relative to total processing in 2001. So, it would not likely be a significant source of bias over the year.

5.4.5 The Bank of Canada's detection rate

The estimates treat the detection rate reported by the Bank of Canada as a benchmark for complete detection and, in effect, assume that the Bank has a perfect ability to detect the counterfeits among the notes that it processes. As a result, the estimates of fake notes in circulation will be biased downwards if the Bank cannot detect all the counterfeits in the batches that it processes. This source of bias is probably small, or non-existent, since the Bank uses undisclosed security features in its detection process.[19]

5.4.6 Overall bias

The resulting estimates of circulating counterfeits are thus conditional on the sources of bias. All but one of the identified biases result in conservative estimates, in that they overstate the number of counterfeit notes in circulation. Although the remaining bias is ambiguous, its effects are likely to be small.

6. The Number and Value of Counterfeit Notes in Circulation

Table 7 provides estimates of the number of counterfeits in circulation for each denomination. As discussed above, the two PFP methods provide floor and ceiling estimates. As can be seen, the differences between the two methods are substantial: the PFP' estimate is more than nine times the PFP estimate for the $100 note. When the COMP results are compared with the basic LOC and PFP results, there is uniformity with respect to these estimates. This uniformity is remarkable in that the LOC and PFP methods do not share

19. The U.S. Treasury also makes this assumption in developing its estimates. Allison and Pianalto (1997) concede, however, that the Federal Reserve detects only "virtually all counterfeit notes," not *all* counterfeits, in the notes it processes.

common data. The results of both the LOC and the COMP approach are both close to those of the minimal PFP approach that is based on the assumption that no detections take place outside the monetary authority. This result for COMP may appear to conflict with the observation that the majority of counterfeit detections are made by the general public. The seeming inconsistency is explained by the fact that public detections appear to be the product of a low efficiency of public screening combined with a high rate of currency turn-over.

The COMP approach produces some interesting by-products. It suggests that the detection rate by the public per turnover of currency is from 6 per cent to 13 per cent as effective as screening by the central bank (Table 6). The COMP approach also provides estimates of turnover rates for currency in circulation, ranging from a low of 6.7 times per year for $100 notes to 33.0 times for $10 notes. The calculated life of counterfeits ranges from five months for $5 notes to one year for $100 notes.

The richness of results of the COMP approach reflects the considerably greater use of data than for either the LOC or the PFP approach. The analysis does show that both the LOC and PFP approaches are good approximations for the COMP method. In particular, the PFP approach uses data that are readily available to the monetary authority through its normal operations. While the data for the COMP approach are less likely to be readily available, the effort to collect these data would allow the use of the COMP method as a cross-check on the continuing suitability of the PFP approach as a ready indicator of the extent of counterfeiting.

The COMP method provides a preferred estimate of circulating counterfeits because it combines features of both the PFP and LOC approaches to overcome their shortcomings. The COMP method suggests that approximately 84,047 counterfeit notes with a value of $5.5 million were circulating in Canada during 2001. It also indicates that, on average, counterfeit notes circulate undetected for a period between 5 months for $5 and $10 notes to 12 months for $100 notes. The estimated stock of circulating counterfeit notes is approximately 63 per cent of the number of notes detected over the year. This difference

can be accounted for by the fact that no denomination remains in circulation for more than a year.

For the general public, the real concern is the chance of getting a counterfeit note when they make a transaction. If, as the COMP estimates suggest, $5.5 million worth of counterfeit notes circulate among the $36 billion worth of authentic currency outstanding, the chance of getting a counterfeit had a value of $0.014 per $1,000 of transactions in 2001.[20]

How credible are these estimates? Unfortunately, the inability to observe the counterfeits in circulation rules out a definitive answer. Nevertheless, there is some indirect evidence. The estimates show that in 2001 the problem of circulating counterfeits was primarily an issue for the high-denomination notes. This finding is consistent with what would be expected, given the counterfeiters' incentives and the small differences in the production costs of different denominations. The implied rates of detection by denomination are also suggestive. There appear to be substantial differences in the public's effectiveness in screening different denominations. For example, the public appears much more effective at screening high-denomination notes. This finding also appears consistent with expectations. There is a greater incentive to devote effort to screening $100 notes than $5 and $10 notes.

7. Conclusions

This study has examined different aspects of the problem of counterfeiting in Canada. In doing so, it has developed and used an innovative technique for estimating counterfeit currency in circulation that combines elements of previous approaches and provides estimates for 2001. On this basis, the following conclusions can be made with respect to the counterfeiting of Canadian currency:

- over the past decade, technological developments have increased the threat to currency from counterfeiting
- the threat of impaired confidence in currency issues, and currency generally,

20. This assumes that counterfeit notes turn over at the same rate as authentic notes of the same denomination.

can be compounded by public perceptions that may not be based on actual experience

- even with recent higher levels of counterfeiting activity, bogus notes still accounted for no more than than 0.01 per cent of the notes in circulation during 2001, or fewer than one counterfeit note for every 290 Canadians
- the value of outstanding counterfeit notes was approximately $5.5 million, or 19 cents per person, in 2001
- the incidence of counterfeiting in 2001 was predominantly a problem of $100 notes

Further research is needed into how different security features used in currency design can deter counterfeiters. Unfortunately, few central banks release statistics regarding the counterfeiting of their currency.[21] The most readily available data are likely to be detections or rates of detection in central bank processing, neither of which measures the volume of counterfeits in circulation—the best indicator of the degree to which a currency's security features have deterred counterfeiters.

There would be substantial benefits from applying the procedure presented here to derive comparable estimates for other countries. Currency operations elsewhere vary substantially in many dimensions, including currency design, printing techniques, security features, and the substrate on which currency is printed. Knowledge of the various international counterfeiting experiences would provide a basis for evaluating the deterrent effects of different features and their combination.

The probability that counterfeit notes accounted for only approximately 0.008 per cent of the currency in circulation in 2001 should not be grounds for complacency: the technology available to counterfeiters continues to advance at a rapid pace.

Public policy towards counterfeiting will be influenced by an inherent paradox of crime prevention. The threat of a crime, in some sense, should not be measured by actual crime rates, but by the rates that would be observed in the absence of prevention. The observed counterfeiting levels reflect the substantial costs for features such as elaborate designs,

21. Germany provided data on annual detections from processing before it adopted the euro. The United States has made similar data available on an occasional basis.

security devices, and distinctive paper incurred by the Bank of Canada in its efforts to prevent the illicit duplication of its currency. There are also the private costs borne mainly by retailers in their efforts to avoid accepting counterfeits, as well as the public costs of education, policing, and the administration of justice. Assuring appropriate policy responses to counterfeiting is vital, because failure to deal with counterfeiting would threaten the public's confidence in all or a part of a country's currency, requiring greater preventive expenditures by currency issuers and users. Law-enforcement agencies and the courts must reflect these realities in dealing with cases of counterfeiting.

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Chart 1

Pattern of Recoveries for $100 Counterfeit Series, 1998–2001

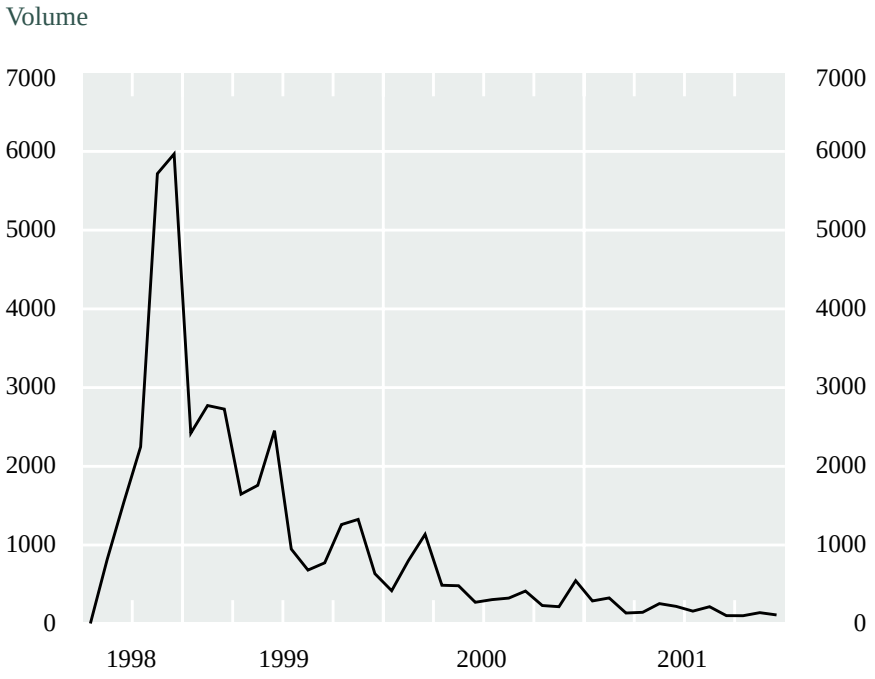

Table 1: Currency facts for 2001

	Value of notes outstanding ($millions)	Share of value outstanding (%)	Value per capita ($)	Number of notes out-standing (thousands)	Share of number outstanding (%)	Number of notes per capita
$5	727	2.2	23.4	145,421	14.5	4.7
$10	948	2.9	30.6	94,813	9.5	3.1
$20	10,094	30.9	325.4	504,705	50.3	16.3
$50	4,869	14.9	157.0	97,382	9.7	3.1
$100	16,016	49.0	516.3	160,156	16.0	5.2
Total[a]	32,654	100.0	1,052.6	1,002,478	100.0	32.3

a. $35,561 million if $1, $2, and $1,000 notes are included for a total of 1,277 million notes outstanding.

Table 2: Counterfeits Seized or Detected: 1993-2001*

Year	Total detected	Seized by police	Detected in use (Bank plus private sector)		Photocopies and ink-jet copies detected in use		Detection in private sector[a]	
			Number	Share of total detected (%)	Number	Share detected in use (%)	Number	Share detected in use (%)
1993	73,279	18,978	54,301	74.1			32,149	59.2
1994	109,923	30,739	79,184	72.0			54,871	69.3
1995	55,658	6,325	49,333	88.6			32,264	65.4
1996	86,860	15,986	70,874	81.6	64,914	91.6	33,919	47.9
1997	109,880	14,432	95,448	86.9	92,716	97.1	55,065	57.7
1998	131,123	9,150	121,973	93.0	120,002	98.4	95,906	78.6
1999	111,357	16,706	94,651	85.0	92,645	97.9	75.399	79.7
2000	104,656	10,420	94,236	90.0	92,097	97.7	74,213	78.8
2001	137,045	8,128	128,917	94.1	128,479	99.7	100,121	77.7

* Excludes $1 and $2 notes.

a. The remaining notes detected in use were found in Bank of Canada processing.

Table 3: Alternative Measures of Counterfeiting

Measure	Availability	Usefulness	
Number detected	High: data published by the Bank of Canada	Limited	Measures cost to public from accepting counterfeits
Parts per million in central bank processing	Moderate: data collected by the Bank of Canada	Moderate	Measures rate at which central bank detects counterfeits in its processing. Changes may indicate trends in outstanding number of counterfeits, frequency of processing, or efforts to target processing to areas where threat of counterfeiting is greatest.
Counterfeits in circulation	Must be estimated	High	Measures both success of counterfeiters and threat to currency
Current introduction into circulation	Unknown	High	Measures current introduction of counterfeits and indicates potential vulnerability

Table 4: Estimates of Counterfeits in Circulation Based on Average Circulation and Rate of Detection: 2001

Average circulation of counterfeits	Counterfeit notes in circulation
1 day	350
1 week	2,500
1 month	10,750
1 year	129,000
5 years	645,000
Annual rate of detection: 129,000 notes	

Table 5: Data for Estimating Outstanding Counterfeits: 2001

	$5	$10	$20	$50	$100	Total	Used in
Detection rate per million by Bank of Canada	13.06	147.60	26.02	39.11	264.14	49.06	PFP, PFP', COMP
Public's share of detections	0.67	0.69	0.72	0.85	0.90	0.78	PFP', COMP
Annual detections	5,306	40,791	30,839	5,275	46,649	128,860	LOC, COMP
Public detections	3,577	27,942	22,285	4,483	41,783	100,070	COMP
Life of counterfeit notes[a] (years)					1.04		LOC, COMP
Life of authentic notes (months)	23	22	42	73	108		COMP
Outstanding stocks (million)	145.4	94.8	504.7	97.4	160.2	1,002.5	PFP, PFP', COMP

Source: Bank of Canada, Department of Banking Operations
a. Derived from a designated series of $100 counterfeit notes.

Table 6: Estimates of Outstanding Counterfeits: 2001

	$5	$10	$20	$50	$100	Total
(A) PFP method						
Number of counterfeits in circulation	1,900	13,995	13,132	3,808	42,303	75,138
Value of counterfeits in circulation ($)	9,500	139,950	262,640	190,400	4,230,300	4,832,790
(B) PFP' method						
Adjusted detection rate	40.1	468.6	93.8	260.5	2532.2	
Number of counterfeits in circulation	5,829	44,429	47,345	25,365	405,550	528,518
Value of counterfeits in circulation ($)	29,145	444,290	946,900	1,268,250	40,555,00	43,243,585
(C) LOC method						
Estimated life of counterfeit[a]	0.22	0.21	0.40	0.70	1.04	
Number of counterfeits in circulation	1,175	8,642	12,473	3,708	48,518	74,513
Value of counterfeits in circulation ($)	5,875	86,420	249,460	185,400	4,851,800	5,378,655

Table 6: Estimates of Outstanding Counterfeits: 2001 (cont'd)

	$5	$10	$20	$50	$100	Total
(D) COMP method						
Efficiency of public screening	0.056	0.057	0.089	0.106	0.128	
Annual turnover	31.6	33.0	17.3	10.0	6.7	
Life of counterfeits (years)	0.38	0.36	0.47	0.81	1.04	
Number of counterfeits	2,012	14,840	14,421	4,259	48,515	84,047
Value of counterfeits ($)	10,060	148,400	288,400	212,950	4,851,800	5,511,310

a. The life derived for the counterfeit $100 note serves as an anchor to calculate the life of counterfeits of all other denominations by extrapolating from the relative lives of authentic notes.

Table 7: Comparison of Estimates: Number and Value of Counterfeit Notes in Circulation

Method	Denomination					
	$5	$10	$20	$50	$100	Total
Number (per cent of total)						
PFP	1,900 (2.5)	13,995 (18.6)	13,132 (17.5)	3,808 (5.1)	42,303 (56.3)	75,138 (100)
PFP’	5,829 (1.1)	44,429 (8.4)	47,345 (9.0)	25,365 (4.8)	405,550 (76.7)	528,518 (100)
LOC	1,175 (1.6)	8,642 (11.6)	12,473 (16.7)	3,708 (5.0)	48,515 (65.1)	74,513 (100)
Composite	2,012 (2.4)	14,840 (17.7)	14,421 (17.2)	4,259 (5.1)	48,515 (57.7)	84,047 (100)
Value ($) (per cent of total value)						
PFP	9,500 (0.2)	139,950 (2.9)	262,640 (5.4)	190,400 (3.9)	4,230,300 (87.5)	4,832,790 (100)
PFP’	29,145 (0.1)	444,290 (1.0)	946,900 (2.2)	1,268,250 (2.9)	40,555,000 (93.8)	43,243,585 (100)
LOC	5,875 (0.1)	86,420 (1.6)	249,460 (4.6)	185,400 (3.5)	4,851,800 (90.2)	5,378,655 (100)
Composite	10,066 (0.2)	148,400 (2.8)	288,400 (5.8)	212,950 (3.9)	4,851,500 (88.0)	5,511,310 (100)

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