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The Social Costs of Currency Counterfeiting

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Abstract

Currency counterfeiting is costly for society. Law enforcement agencies allocate substantial resources to deter, detect and prosecute counterfeiting operations, households and businesses suffer a direct loss to counterfeiters and undertake costly prevention measures, and central banks spend considerable resources upgrading and improving the security of banknotes. Without these prevention efforts, there is a risk that the public could lose confidence in the currency and reduce its use relative to more costly payment alternatives.

This paper examines the social costs of counterfeiting in Australia. First, we provide some statistics on counterfeiting domestically and compare Australia's experience with some other economies internationally. We find that the direct costs of counterfeiting in Australia are relatively low when compared with other economies, but that there can be substantial deadweight costs associated with prevention efforts and losses of confidence in the currency.

Second, we focus on quantifying the effect of a loss of confidence in the currency. To do this, we estimate a structural vector autoregression using the Australian data. In response to a positive one standard deviation counterfeiting shock, the demand for banknotes declines and the use of credit cards and bank deposits increase. These results are consistent with the presence of substitution effects. Using a scenario to quantify the real resource costs associated with these substitution effects, our estimates suggest that an increase in counterfeiting of around A$140 000, spread over ten years, leads to a total increase in social costs of A$7.0 million. Although the statistical uncertainty implied in the model and scenario estimates is large, the results suggest that there are significant pay-offs from efforts to prevent and deter counterfeiting activity in Australia.

JEL Classification Numbers: C32, E42

Keywords: currency counterfeiting, social cost, structural vector autoregression

Table of Contents

The Social Costs of Currency Counterfeiting

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1. Introduction

Currency counterfeiting is costly for society: law enforcement agencies allocate resources to deter, detect and prosecute counterfeiting operations; households and businesses who mistakenly accept counterfeits as payment suffer a direct loss; and the wider public can lose confidence in the functionality of the currency. This is one reason why policymakers in Australia and around the world allocate substantial resources to the deterrence, detection and prosecution of counterfeiting activity. Nevertheless, little work has been done to quantify the social costs of counterfeiting despite its policy relevance.

The first part of this paper examines the social costs of counterfeiting and presents some key facts comparing the social costs in Australia to other economies. We find that the level of counterfeiting in Australia is relatively low compared with other economies, and that businesses incur a greater fraud loss from accepting counterfeits than households. We also discuss the costs incurred in counterfeiting prevention and the costs associated with diminished confidence in the currency; these two costs are likely to form a substantial proportion of the social costs of counterfeiting, but are difficult to measure.

Although the facts we present are informative, they do not provide information about the effects of counterfeiting on the demand for different methods of payment. This motivates the second part of this paper. We use a structural vector autoregression (VAR) to estimate the effect of an increase in counterfeiting activity on the demand for banknotes and close payment substitutes like debit cards and credit cards. We identify counterfeiting shocks in our structural model by assuming that these shocks take time to affect the demand for different methods of payment.[1] This is motivated on the grounds that it takes time for the public to learn about the prevalence of counterfeiting and adjust their behaviour.

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1 Counterfeiting shocks as defined here are conceptually similar to counterfeiting attacks referred to in the literature.

The model provides evidence that increased counterfeiting activity affects the payment methods chosen by the public. Based on the historical data, a one standard deviation increase in counterfeiting activity leads to a decline in the demand for banknotes of 0.20 per cent, which is consistent with some loss of confidence in currency. In response to the same counterfeiting shock, bank deposits increase by 0.04 per cent and credit card use increases by 0.16 per cent. These responses are consistent with substitution effects between methods of payment – specifically, a move away from currency and towards electronic means of payment.

We then estimate the increase in social costs due to differences in the costs of making payments electronically, as compared to using cash. Using transaction cost estimates from three Australian studies, we find that the average increase in social costs associated with the counterfeiting shock (where counterfeits detected increase by a cumulative total of around A$140 000 spread over a period of ten years) is A$7.0 million. The scale of this effect can be explained by confidence effects and the scale of the payments system compared to counterfeiting. Also, it should be noted that these estimates are subject to a degree of uncertainty.[2]

This paper contributes to two areas of the literature. Our first contribution is to the small but growing literature about counterfeiting (see, for example, Chant (2004a), Fung and Shao (2011b) and Kim and Turton (2014)). Our second is to quantify the effects of counterfeiting on currency demand and alternative payment methods. This provides more information about the overall social costs of counterfeiting and is a new contribution. The main focus of existing empirical work has been to estimate the stock of counterfeits circulating from the level of counterfeits detected. Judson and Porter (2003) were the first to develop estimates for the United States, while Chant (2004b) and Bose and Das (2013) extend their methodologies to Canada and India. Another empirical paper examines some correlates of counterfeiting (Morris, Copes and Perry-Mullis 2009).

The rest of this paper is structured as follows. Section 2 discusses the channels through which counterfeiting affects the demand for currency. Section 3 presents some facts on the social costs of counterfeiting and compares the experience in Australia to other economies. Section 4 presents a structural model of counterfeiting and its effects on methods of payment. We also use this model to help quantify the

2 See Section 4.4 below for a detailed discussion.

overall social costs of counterfeiting. A range of robustness checks is explored in Section 5. Section 6 concludes.

2. Counterfeiting and Confidence

Counterfeiting can affect the demand for currency through a loss of confidence in the use of currency. For example, counterfeiting can affect a currency's functions as a store of value and a medium of exchange. It is the perception of risk that affects confidence. Confidence weakens if the public perceives that there is a greater risk that they could unknowingly accept a counterfeit as payment. For example, heightened media coverage of counterfeiting activity could increase the perceived risk of counterfeiting, even if the level of counterfeiting activity is low.

The idea that confidence weakens with perceived risk has been established in theoretical literature on counterfeiting. A striking finding in search-theory models has been that the threat of counterfeiting can, in the extreme, eliminate the use of currency altogether (Nosal and Wallace 2007; Li and Rocheteau 2011; Shao 2013). These models have only two types of money: genuine fiat money and counterfeits. A deterioration of the use of currency can have an impact on output and welfare. The threat of counterfeiting in these models materialises through low production costs of counterfeits and their effect on the steady state of the economy. Low production costs (for a given quality of counterfeiting) can affect the equilibrium outcome even in the absence of counterfeiting. For example, Li and Rocheteau (2011) find that the threat of counterfeiting can affect the value and velocity of money, as well as output and welfare, even when counterfeits do not actually circulate. Moreover, Monnet (2005) suggests that counterfeiting can be inflationary if the production costs of counterfeiting are low enough.

Another insight into the effects of counterfeiting on confidence is drawn from the canonical model of money as a medium of exchange (Kiyotaki and Wright 1993). Kiyotaki and Wright show that a 'tipping point' can materialise where currency will be abandoned in favour of other payment mechanisms. This implies that at sufficiently high levels of counterfeiting activity, it is possible that the public could abandon the currency altogether, or at least particular denominations.

The literature on the economics of crime and punishment offers insights into the optimal public policy response to counterfeiting activity (see Becker (1968)). For example, one way to think of an individual's decision to produce counterfeits is as a trade-off between the expected benefits and the expected costs from production. In this simple stylised framework, one could think of a counterfeiter's expected costs as the probability of detection multiplied by the size of the punishment if caught, plus production costs. A counterfeiter's expected benefits could be thought of as the probability of avoiding detection multiplied by the notional value of counterfeits produced.

This framework suggests that measures taken to increase the expected costs or decrease the expected benefits of counterfeiting will lower the incidence of counterfeiting. Increasing the probability of detection both increases the counterfeiter's expected costs and decreases the expected benefits. For example, issuing a new banknote series with harder-to-counterfeit security features would work to both raise the counterfeiter's production costs and increase the probability of detection. Public education campaigns also increase the probability of detection and are a critical communication strategy used in Australia. Finally, measures taken to increase the allocation of police resources to detect counterfeiting also act as a deterrent.

Similar conclusions have also been made in the theoretical literature on counterfeiting. Kultti (1996) finds that counterfeiting does not occur in equilibrium if the probability of detection is high enough. Combinations of anti-counterfeiting efforts are found to be more effective in reducing counterfeiting than single measures (Fung and Shao 2011a). Quercioli and Smith (forthcoming) find that the maximum social costs of counterfeiting are lower when prevention efforts are greater. Green and Weber (1996) find that the introduction of a new banknote series can reduce counterfeiting activity and lower the level of law enforcement required to mitigate counterfeiting further. However, notwithstanding the large theoretical literature on counterfeiting, and some measures of the average levels of counterfeiting, there is almost no literature that attempts to quantify the social costs of counterfeiting.

3. The Social Costs of Currency Counterfeiting

In this section, we present some statistics on the social costs of counterfeiting, and compare the Australian experience to some other economies. Chant (2004a) identifies three types of costs: the implied transfer from households and businesses to counterfeiters; prevention costs; and loss of confidence. Redistribution effects are transfers of wealth. They imply a gain to a counterfeiter at the expense of the household or firm who holds the counterfeit at the point of detection. This redistribution has no net effect on the economy as a whole, and is in this sense not a social cost (but could be seen as undesirable by society). In contrast, prevention costs and a loss of confidence are deadweight losses. They imply a loss of production or forgone income that would have otherwise occurred in the absence of counterfeiting, and are in this sense a social cost. Deadweight losses affect all agents in the economy as they draw resources away from their most productive use.

3.1 Counterfeits Passed into Circulation

Counterfeits falsely exchanged for goods and services result in the transfer of wealth from private agents, either households or businesses, to counterfeiters. If a counterfeit is passed more than once in circulation, the loss is borne by the last holder of the counterfeit.[3]

Many central banks and law enforcement agencies collect data on counterfeits detected and removed from circulation. The total notional value of counterfeits detected in these data provide one measure of the redistribution of wealth. In absolute terms, the levels of counterfeiting experienced in these economies are low (Table 1). For example, the euro area, which exhibits the highest level of counterfeits detected in circulation in our sample of economies for which comparable data are available, only detected the equivalent of A$45 million of counterfeits in 2013.

3 It is illegal in Australia under the *Crimes (Currency) Act 1981* to knowingly ‘utter’ (pass) a counterfeit.

Table 1: Cost to the Public from Receiving Counterfeits
2013

	Counterfeits detected in circulation (A$ million)	Counterfeits detected per million banknotes in circulation (parts per million)	Notional value of counterfeits detected per capita (A$)
Australia	1.2	16	0.05
Canada	1.9	29	0.06
Euro area	44.9	46	0.13
Mexico	6.8	98	0.06
United Kingdom	19.0	230	0.30

Note: Calculations made using average exchange rates over 2013 and the level of banknotes in circulation as at the end of February 2013, where available (we use the average level over 2013 for Canada)
Sources: Authors' calculations; Central bank websites; RBA; World Bank

Nevertheless, when measured in terms of redistribution per person, there is still considerable variance across economies. The notional value of counterfeits detected per capita in Australia in 2013 is relatively low at A$0.05 compared with some other economies in our sample. This contrasts with the United Kingdom, for example, which has experienced relatively high levels of counterfeiting per capita over recent years (though it is still low in absolute terms).

The data suggest that businesses detect more counterfeits than the general public in Australia. Of the counterfeits detected in these data in 2013, the general public detected approximately 10 per cent, businesses detected around 34 per cent, the RBA, banks and other cash management companies detected another 32 per cent, while the remainder is not specified in the data.[4]

The impact of fraud loss from counterfeiting can be a significant cost for some agents in the economy. Low-income households use cash more than other payment methods and could be exposed to fraud losses from counterfeiting more than other households. For low-margin businesses, it is possible that the loss from receiving a counterfeit could exceed daily profits. For example, as highlighted by the Bank of Canada, grocers operating on margins of 1 to 2 per cent would have to sell up to

4 These gaps in the data are often due to unfamiliarity with the paper form that is required to be submitted with counterfeits to the Australian Federal Police.

C$5 000 worth of goods to recoup the loss from accepting a single C$50 counterfeit (Bank of Canada 2015).

The incidence of counterfeiting also varies by industry. The detections data suggest that the most common businesses to receive counterfeits in Australia are supermarkets & grocery stores and restaurants, cafes & fast food outlets which receive almost half of all counterfeits by businesses (Table 2). This could be explained by high-frequency, low transaction value payments in cash being made in these stores, making them potentially more susceptible to the passing of a counterfeit. In contrast, clothing, hardware and entertainment stores receive less counterfeits, which could be explained by a greater prevalence of electronic payments and less frequent transactions made in cash, as well higher transaction values when purchasing the goods sold.

Table 2: Business Detections of Counterfeits in Australia

2013

Business type	Counterfeits per outlet	Per cent of total
Supermarkets & grocery stores	0.17	26.4
Restaurants, cafes & fast food outlets	0.02	20.4
Post offices	0.15	11.5
Petrol stations	0.13	8.0
Hospitality	0.02	6.3
Department stores	0.36	5.8
Liquor	0.16	5.8
Gaming	0.10	4.9
Hardware	0.05	4.5
Entertainment	0.05	2.7
Clothing	0.01	2.3
Other[(a)]	na	1.5

Note: (a) Includes medical, chemist and transport-related businesses

Sources: ABS; Company and industry websites; RBA

3.2 Prevention Costs

Prevention costs are incurred in efforts made by private agents, law enforcement agencies and the central bank to reduce the risk of counterfeits being passed into circulation. We consider the costs incurred by each of these agents in turn.

Some private agents take time to authenticate each banknote at the point of exchange. The authentication of banknotes often involves checking for security features embedded in the banknote. On Australian banknotes these could include microprinting, raised print, a see-through registration device or a shadow image. Some features are only machine-readable and require the purchase of equipment to authenticate them. The authentication process takes additional time at the point of exchange, which is costly.

Law enforcement prevention costs include the policing and judicial expenses involved in shutting down and prosecuting counterfeiting operations. As law enforcement agencies are typically resource-constrained, the opportunity cost of resources used to curb counterfeiting can be significant. For example, counterfeiting can draw resources away from investigating other criminal activity. However, it is also possible that law enforcement efforts allocated across different types of crime are not necessarily substitutes for one another, but can also be complementary. For example, in Australia, there have been illegal drug operations or episodes of organised crime that have also been associated with seizures of counterfeit notes.

Central bank prevention costs include conducting research into improving security features for banknotes, developing and issuing new banknote series, monitoring and analysing counterfeit activity, conducting information programs for the public and the police in counterfeit detection, and developing programs with the police to deter counterfeiting. In Australia, significant resources are allocated to these areas to keep counterfeiting activity at low levels.

The issuance of a new banknote design can also help mitigate counterfeiting activity. However, the costs of production and issuance of a new banknote series can be significant. Published estimates of these costs are scarce. The US Bureau of Engraving and Printing (2004, 2005, 2007, 2009, 2011, 2014) indicates that the average research and development expenditures between 2003 and 2013 were over US$11 million per year. The Bank of Canada reportedly spent close to C$20 million in recent times developing a new polymer series of banknotes (Bank of Canada 2015). The non-production costs of issuing a new banknote series are, therefore, likely to be a substantial share of the total replacement cost of the stock of banknotes in circulation.

3.3 Loss of Confidence

The most difficult effect to quantify, however, is the effect on the public's confidence in currency. With large counterfeiting episodes, there can be reduced use of currency when making transactions and thus a decline in the overall demand for banknotes. This gives rise to two additional sources of social costs.

First, currency issuers generate revenue through the issuance of banknotes, otherwise known as seigniorage. Seigniorage is the difference between interest earned on banknotes issued into circulation and the costs of producing and distributing banknotes. Profits from seigniorage are typically a large part of a central bank's revenues.[5] Hence, a reduction in the stock of banknotes in circulation, due to a loss of confidence, can result in less seigniorage revenue available for use by the public sector. Other things equal, less seigniorage revenue could mean that more taxation revenue is required elsewhere. If the new taxation distorts economic incentives, this could have an effect on the level of output in the economy, which would be considered deadweight loss.

The second source of increased social costs is the effect on the public's choice of payment methods in transactions. A decline in the demand for banknotes following a loss of confidence could mean that private agents substitute cash for other payment types. If the social costs of conducting a transaction are higher for other payment types, this is an additional source of deadweight loss.[6]

Studies from Australia have estimated the resource costs of using different methods of payment.[7] These include fixed costs, such as the provision of bank infrastructure and ATMs, and variable costs, such as the time required to complete a transaction. In Australia, studies have found that the average-sized cash transaction incurs lower social costs than average-sized credit card and debit card transactions (Schwartz *et al* 2008; Stewart *et al* 2014). In another Australian study, cash is still found to be

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5 See RBA (1997) for a description and estimates of seigniorage in Australia.

6 There are other private costs involved that are more difficult to quantify because they take the form of losses in consumer utility. Private agents lose their anonymity when conducting many types of electronic transactions (Brits and Winder 2005). However, some consumers will value the benefits of credit card loyalty programs.

7 The social cost of conducting a transaction can be measured using resource costs, which capture the resources required to facilitate a transaction.

the most common payment method used, despite the rise in the use of electronic payments over recent years (Meredith, Kenney and Hatzvi 2014).[8] These results suggest that if an increase in counterfeiting causes a shift away from cash, the aggregate social cost of the payments system could increase.

4. A Structural Model of Counterfeiting and Methods of Payment

In this section, we use a structural VAR to identify the effects of counterfeiting activity on payments activity. This specification is designed to capture substitution effects between payment methods when there is a shock to counterfeiting.[9] We then use the implied substitution effects in conjunction with data from previous payment cost studies to estimate the social cost of counterfeiting associated with a loss of confidence in the currency.

4.1 The Data

We use quarterly Australian data covering the sample period from March quarter 2000 to December quarter 2013.[10] The model includes four endogenous variables – the stock of banknotes in circulation, the stock of bank deposits, the stock of credit card debt, and the flow of counterfeits detected and removed from circulation (Table 3). The stock of banknotes in circulation represents the demand for

8 Ossolinski, Lam and Emery (2014) provide some evidence that the share of payments made using cash is declining.

9 The number of counterfeits detected in circulation reflects the interaction of the demand and supply of counterfeits among criminals, and the rate of detection by the public or authorities. In the context of this analysis, a shock to the number of counterfeits observed is likely to be related to developments that affect the demand and supply of counterfeits, including technological advancements that reduce the cost of counterfeiting, increase the quality of counterfeits and potentially reduce a criminal's chance of being caught while passing a counterfeit. It is less likely that the counterfeit shocks observed in the data are related to preventative measures since detection efforts and technologies have remained relatively unchanged and there have been no changes to Australia's banknote security features over the sample period.

10 While data exists beyond this end date, it is still susceptible to revisions and is thus excluded from our sample. This is because there can be a delay between the time a counterfeit is detected in circulation and when it is entered into the data at the Counterfeit Examination Laboratory (CEL). One reason for this is that some counterfeits are involved in investigations before they are sent to the CEL. This means that, in any given quarter, revisions can be made to the data in previous quarters.

banknotes and is used to measure the effect of counterfeiting on confidence in the currency. The stock of bank deposits is included to capture the effect of counterfeiting on debit card and eftpos payments.[11] Finally, the stock of credit card debt is included to capture the effect of counterfeiting on credit card payments.[12] While flows data might capture these effects more directly, it is difficult to measure cash transactions in the economy. Another reason to use stocks for banknotes in circulation, bank deposits and credit card debt is to allow for potential long-run (or cointegrating) relationships between these variables.[13] We find in robustness tests below that the stocks data are consistent with flows data. In particular, using the value of eftpos and credit transactions instead of bank deposits and credit card debt yields qualitatively similar results.[14]

Table 3: Model Endogenous Variables

Sample average – 2000:Q1 to 2013:Q4

	Volume ('000)	Value (A$ million)	Ratio to nominal GDP (per cent)
Counterfeits detected in circulation	2	0.1	0.00004
Banknotes in circulation	926 560	38 653	14.1
Bank deposits		166 311	60.9
Credit card debt		35 854	12.7

Sources: ABS; Authors' calculations; RBA

11 There is a structural break in the bank deposit series in 2002:Q2 due to changes in bank reporting. We do not break-adjust the data in the results that follow as there is a risk of falsely removing natural variation in the data. However, we find that using a break-adjusted series in the model produces estimates with signs and magnitudes consistent with the impulse response functions we estimate in Figure 3 below.

12 The ideal variable to capture the effect of counterfeiting on credit card payments would be debt not bearing interest; however, the data are not available for the whole sample period. We use total credit card debt, which is strongly positively correlated with debt not bearing interest.

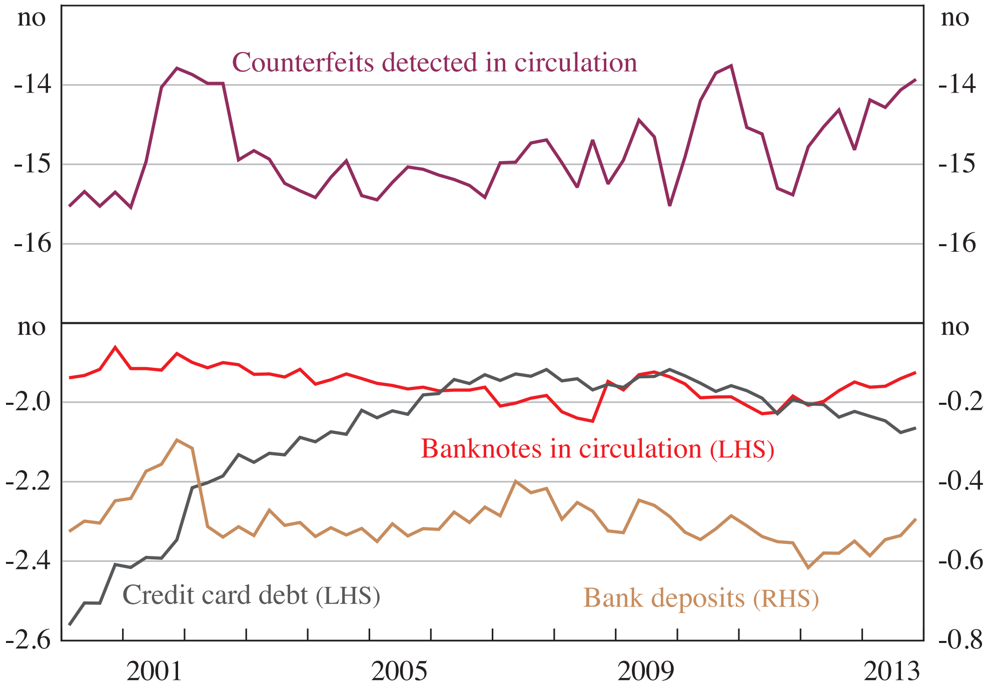
13 Possible cointegrating relationships could be implied by theories of money or transactions demand, for example.

14 See Section 5 below for details. Both payments (flows) data and stocks data can be affected by demand, saving, and wealth shocks. In using either dataset, we assume that these shocks are uncorrelated with counterfeiting activity, which we think is plausible.

The data enters the model in log levels, and all endogenous variables are normalised by seasonally adjusted nominal GDP (Figure 1). This normalisation is motivated in two ways. First, standard models of currency demand suggest that the stock of banknotes in circulation depends on the level of income. Second, this normalisation can account for any demand shocks that could potentially influence the extent of counterfeiting and the demand for payments simultaneously.

Figure 1: Model Endogenous Variables

Normalised by nominal GDP, log levels



Sources: ABS; Authors' calculations; RBA

We also include dummy variables to control for effects of the global financial crisis and seasonal effects. Finally, we include as an additional exogenous variable the quarterly average cash rate in level terms. This is consistent with standard models of currency demand where the return on bank deposits captures the opportunity cost of holding currency.[15] Details of data sources used in the model can be found in Appendix A.

15 The cash rate reasonably captures the variation in at-call deposit account rates. We find high correlation between the cash rate and several at-call deposit account rates, and that using these deposit account rates in the model does not significantly change the results.

4.2 The Model

We identify counterfeiting shocks and estimate their effects on other payment methods using a structural VAR model:

$$\mathbf{A}_0 Y_t = \mathbf{A}_1 Y_{t-1} + \gamma_0 X_t + \varepsilon_t$$

Where Y_t is a vector containing the endogenous variables; and X_t is a vector containing the exogenous variables – the cash rate, financial crisis and seasonal dummy variables. The $\mathbf{A}_1$ matrix captures the effects of lags of the endogenous variables, and the vector γ_0 captures the contemporaneous effect of the exogenous variables in each equation in the system. The matrix $\mathbf{A}_0$ contains information on the contemporaneous relationships between the endogenous variables. The vector of equation residuals, ε_t , are identified as the structural shocks to the system.

We identify counterfeiting shocks using a recursive ordering approach; we restrict the parameters of $\mathbf{A}_0$ such that counterfeiting shocks affect all payment types with a lag.[16] That is, we assume that it takes time for substitution effects to occur following a counterfeiting shock. It may take time for the public to learn about an increase in counterfeiting activity and make the decision to use other payment methods. Also, it may take time for these payment decisions to take effect if the public smooths their consumption.

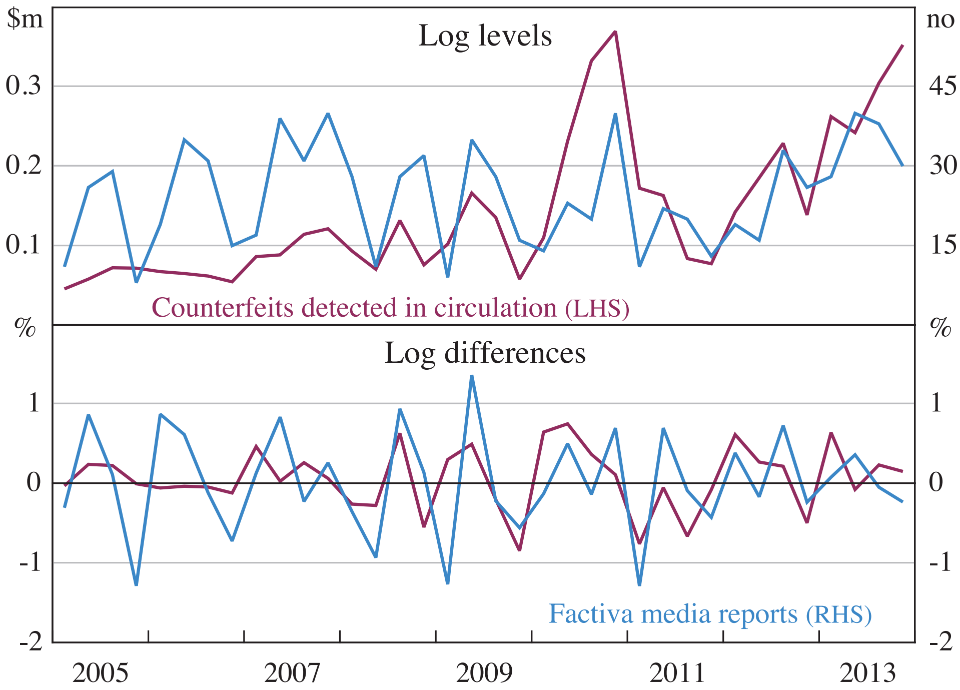
In support of our timing assumption, we examine media coverage of counterfeiting activity as a critical part in the transmission of the effect of counterfeiting on confidence. Figure 2 highlights media reports concerning counterfeiting recorded in the Factiva media database in comparison to actual counterfeiting activity.[17] On first inspection, there appears to be co-movement between media reports and counterfeits detected. Testing for correlation between the log-differenced data, we find evidence of correlation between counterfeits detected and the first lag of the Factiva media reports series, as well as contemporaneous correlation. We also find evidence at the

16 We use Cholesky decomposition with the ordering: banknotes in circulation, bank deposits, credit card debt, counterfeits detected. The ordering of variables before counterfeits detected does not change our results since we are only concerned with identifying counterfeiting shocks.

17 We search for articles within the subject 'Counterfeit/Forgery' with free text *bank note* or note** and search articles from all authors and all sources for all industries in the Australia region.

95 per cent level of significance that counterfeits detected Granger-causes Factiva media reports in a bivariate VAR.[18] This is consistent with counterfeits being detected and then subsequently being reported in the media.

Figure 2: Factiva Media Reports and Counterfeiting



Sources: Authors' calculations; Factiva; RBA

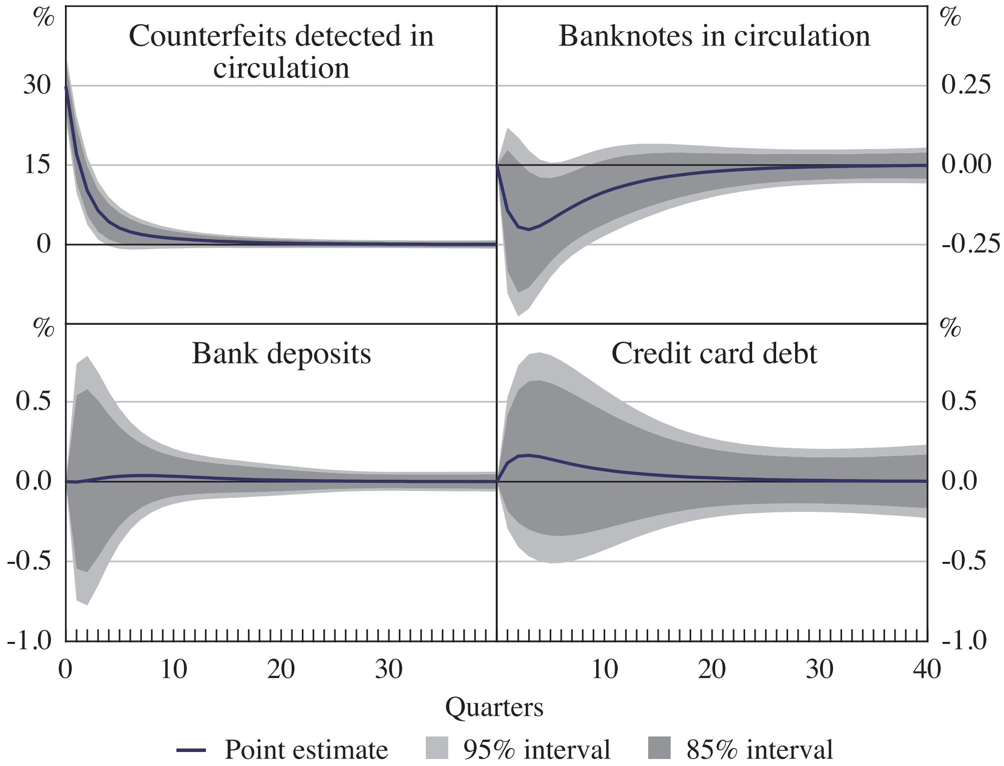
4.3 Results

We estimate the effect of a counterfeiting shock on the different payment methods. Figure 3 shows the impulse response functions associated with a positive one standard deviation shock to counterfeits detected in circulation, which is an increase of 30 per cent in the first quarter (as shown in the top left panel of Figure 3). The shock has some persistence with increases in counterfeits detected for around five quarters before subsiding.

18 We also test the relationship between media reports and counterfeiting activity using media reports detected and recorded by the Counterfeit Analysis team, internal to the Reserve Bank of Australia. We again find evidence that counterfeits detected Granger-causes media reports.

Figure 3: Impulse Response Functions – Baseline Model

Response to counterfeiting shock



Note: Bootstrap confidence intervals using 1 000 replications

Point estimates suggest that the value of banknotes in circulation declines in response to a counterfeiting shock, which is consistent with a loss of confidence in the currency. The peak effect of the response occurs two quarters after the shock at –0.20 per cent. The stock of bank deposits responds positively to the shock by 0.04 per cent, consistent with the public conducting more electronic transactions through their deposit accounts, such as eftpos and debit card transactions. Finally, the response of the stock of credit card debt is also positive which suggests that the public also increase their use of credit cards following a shock. The increase reaches a maximum of 0.16 per cent after two quarters.

The impulse responses in Figure 3 are consistent with a loss of confidence in the currency and substitution to alternative methods of payment. In particular, without imposing any restriction on the change in overall transaction activity, we find that a 0.2 per cent decline in the use of currency is exactly offset by a 0.2 per cent increase in electronic transaction activity – taking the changes in stock variables as an indicator of the change in electronic card activity. The cumulative effects for these variables also closely offset, with a 2.1 per cent decline in the use of currency and a

2.3 per cent increase in electronic transaction activity over the ten years following the shock.

Nevertheless, Figure 3 also illustrates that there is considerable statistical uncertainty around these point estimates. The 95 per cent and 85 per cent confidence intervals for the responses of bank deposits and credit card debt encompass zero.

Using the same variables in a potentially cointegrated system implies that the response of bank deposits is larger and statistically significant (Appendix B). In sum, we view these results as consistent with the presence of substitution effects, but they are not identified with much precision. This is not surprising given that there have been relatively few episodes of large counterfeiting operations in Australia, and so it is hard to pin down the effects of counterfeiting on people's behaviours.

4.4 Quantifying the Social Cost of Substitution Effects

To provide some indication of the social costs associated with the counterfeiting shock identified in the structural VAR model above, we undertake the following scenario analysis. We consider the one standard deviation shock to counterfeiting identified in Figure 3. We assume that credit card transactions and deposit account transactions increase by the same proportion as credit card debt and bank deposits in response to the counterfeiting shock in Figure 3, and that these additional credit card and deposit account transactions would otherwise be made using cash in the absence of the counterfeiting shock.

The counterfeiting shock reflects a cumulative increase in counterfeits detected totalling around A$140 000 spread over a period of ten years. The size of this counterfeiting shock is consistent with data on previous known counterfeiting operations in Australia. The counterfeiting shock is around the same size of a number of smaller counterfeiting operations which were shut down fairly quickly, but smaller than some more significant counterfeiting operations in the data.

Deposit account transactions could be made using a proprietary debit card (e.g. eftpos) or a scheme debit card (e.g. MasterCard/Visa debit). We assume that the effect of counterfeiting on bank deposits is attributable to substitution from cash to eftpos. This gives us a conservative estimate of the social cost associated with the counterfeiting shock, as the social cost associated with using eftpos is less than a scheme debit card.

To quantify the additional costs associated with the change in payments behaviour, we use cost estimates from previous Australian studies on the resource costs associated with different means of payment.[19] Most recently, Stewart *et al* (2014) estimate that the average size credit card transaction is A$0.99 more expensive than the average size cash transaction, while the average size eftpos transaction incurs broadly the same costs as cash (Table 4). In comparison, a previous study published in 2008 estimated that credit card transactions incur a cost A$0.66 greater than cash, while eftpos transactions cost A$0.12 more than cash, for the average size transaction (Schwartz *et al* 2008). Finally, a joint study produced by the Reserve Bank of Australia and the Australian Competition and Consumer Commission estimated the resource costs to financial institutions associated with both debit and credit card schemes (RBA and ACCC 2000). Cash is found to be A$0.08 more costly than eftpos transactions, while credit card transactions are A$1.87 more expensive than cash transactions. Although the cost estimates provided in each study are not conceptually identical, they are indicative of the social cost of making payments over the sample 2000 to 2013, and so we use the average cost implied across the three studies.[20]

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19 Resource costs measure the resources required to facilitate payments and do not reflect rents sought to compensate for the provision of services. In this way, resource costs are ideal for constructing estimates of social costs.

20 The 2008 and 2014 studies both estimate the resource costs of facilitating payments. However, the 2008 study estimates the costs to consumers in conducting payments, including costs such as tender times, while the 2014 study estimates only reflect the private costs to consumers, such as merchant surcharges and fees. The 2000 study only estimates the resource costs to financial institutions, which represent one component of social costs.

Table 4: Australian Payments Studies of Resource Costs
Cost per average size transaction, A$

	Credit cards	eftpos	Cash
Stewart *et al* (2014)			
Private costs			
Financial institutions – direct payment costs	0.82	0.24	0.20
Merchant	0.66	0.24	0.29
Total cost	*1.48*	*0.48*	*0.49*
Increase in cost over cash	0.99	–0.01	
Schwartz *et al* (2008)			
Production costs			
Financial institutions – direct payment costs	0.59	0.22	0.18
Merchant	0.40	0.31	0.24
Public sector			0.01
Consumer costs	0.22	0.14	0.12
Total cost	*1.21*	*0.67*	*0.55*
Increase in cost over cash	0.66	0.12	
RBA and ACCC (2000)			
Private costs			
Financial institutions – direct payment costs	1.93	0.15	na
Merchant	0.43	0.26	na
Total cost	*2.36*	*0.41*	*0.49*
Increase in cost over cash	1.87	–0.08	

Sources: Authors' calculations; RBA and ACCC (2000, Tables 4.1, 5.1 and 6.1); Schwartz *et al* (2008, Table 11); Stewart *et al* (2014, Table A1)

Under this scenario, a total increase in counterfeits detected of around A$140 000 spread over a ten-year horizon leads to a cumulative increase in credit card transactions of 1.8 per cent over ten years, and 0.5 per cent in total eftpos transactions. This in turn implies a total increase in social costs of A$7.0 million, with estimates averaged over the three transaction cost studies (Table 5).

Table 5: Increase in Social Costs
At average sample levels – 2000:Q1 to 2013:Q4

	Credit card	eftpos	Total
Average number of transactions (million)	332.4	418.8	751.2
Cumulative response to counterfeiting shock (per cent)	1.8	0.5	
Increase in number of transactions (million)	*6.0*	*2.1*	*8.1*
Estimated social costs (A$ million)			
Stewart *et al* (2014)	5.9	0.0	5.9
Schwartz *et al* (2008)	3.9	0.2	4.2
RBA and ACCC (2000)	11.2	–0.2	11.0
Average social cost (A$ million)	*7.0*	*0.0*	*7.0*

Sources: Authors' calculations; RBA; RBA and ACCC (2000, Tables 4.1, 5.1 and 6.1); Schwartz *et al* (2008, Table 11); Stewart *et al* (2014, Table A1)

These estimates indeed imply that the scale of the effect of counterfeiting on social costs is large, and we now discuss three possible explanations for its magnitude. First, the perceived threat of counterfeiting, not the actual threat, influences the public's payments behaviour. If the public perceive a higher probability of receiving a counterfeit than the actual probability (due to media coverage, for example), or believe that the rate of detection is small (implying that the level of counterfeits still circulating is large), then this could justify a large effect.

Second, there is a sizable difference in scale between the payments system and the level of counterfeiting seen in Australia. This means that only a small change in payments behaviour is required to generate significant social costs. For example, the value of credit card payments is around A$47 billion each quarter on average over the sample. While the implied cumulative response of credit card payments to the counterfeiting shock is only 1.8 per cent, this is a total increase of A$0.8 billion in level terms. This leads to an increase in social costs of A$7.0 million (around 0.8 per cent of the value of the increase in credit card payments).

Finally, the impulse response functions in Figure 3 are estimated with large uncertainty. For example, the A$0.8 billion increase in credit card payments is estimated with a confidence interval spanning –A$4.5 billion to A$6.2 billion. An estimate smaller in magnitude within this confidence interval would imply lower social costs and imply the effect of counterfeiting on social costs is smaller in scale.

Notwithstanding these measurement difficulties, the responses suggest that the pay-offs from activities used to prevent and deter counterfeiting are likely to be non-trivial. The level of counterfeiting could be higher in the absence of efforts in law enforcement, education and awareness, and the production of secure banknotes. Moreover, these estimates are novel in the sense that there are no other quantified estimates on the social costs of counterfeiting when associated with a loss of confidence in currency. This analysis helps fill this gap and provides one direction for future work using data in other countries.

5. Robustness of Results

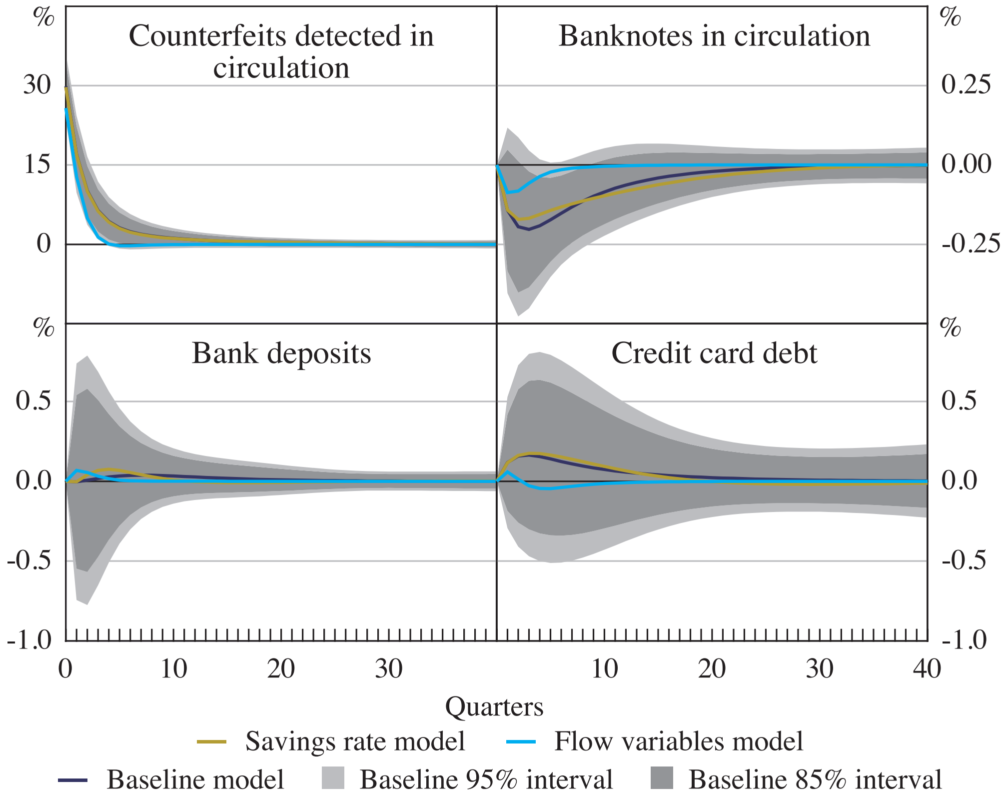
5.1 Alternative Model Specifications

This section discusses the robustness of our results to different model specifications. Figure 4 compares the response of each variable to a counterfeiting shock in our baseline model to the responses using two alternative model specifications: first we introduce the savings rate into the model; second we model variables in flows rather than stocks.[21] These two alternative model specifications test the robustness of our interpretation of the model results as substitution effects. It is possible that the increase in bank deposits in response to the counterfeiting shock reflects the public converting cash used as savings, or a store of value, into bank deposits. It is also possible that the response could reflect the public taking out less cash than they otherwise would. However, the results of this robustness analysis suggest that our baseline results are representative of changes in the public's payments decisions rather than changes in savings behaviour.

21 In separate robustness analyses, we also performed the following variations of the model, with either similar or inconclusive results: different lag lengths; data adjusted for structural breaks; various deposit account rates as an alternative to the cash rate to capture the opportunity cost of holding currency; different monetary aggregate variables; credit card debt not accruing interest as opposed to total credit card debt; payments system variables associated with currency demand models such as eftpos terminals, ATMs per capita, and ATM withdrawals; and, vector error correction models to account for possible cointegrating relationships.

Figure 4: Impulse Response Functions – Alternative Specifications

Response to counterfeiting shock



Note: Bootstrap confidence intervals using 1 000 replications

First, we estimate the model including the savings rate as an additional endogenous variable. This alternative specification captures possible changes in savings behaviour through the savings rate, and leaves the response of each variable to a counterfeiting shock to be interpreted as changes in payment preferences. The responses in all variables are broadly similar to the baseline, which gives us confidence that our interpretation of the impulse response functions as substitution effects between payment methods is plausible.

Second, we estimate a model with the endogenous variables in the form of flows as opposed to stocks. We use debit card expenditure and credit card expenditure rather than bank deposits and credit card debt (see Appendix A for details). These variables directly capture the effect of payments activity. The model implies responses smaller in magnitude for all variables compared to the baseline model. The results are qualitatively similar, with the exception of credit card debt which declines in the medium term, causing the cumulative effect to be slightly negative.

All responses lie within the 85 per cent and 95 per cent confidence intervals of the baseline model.

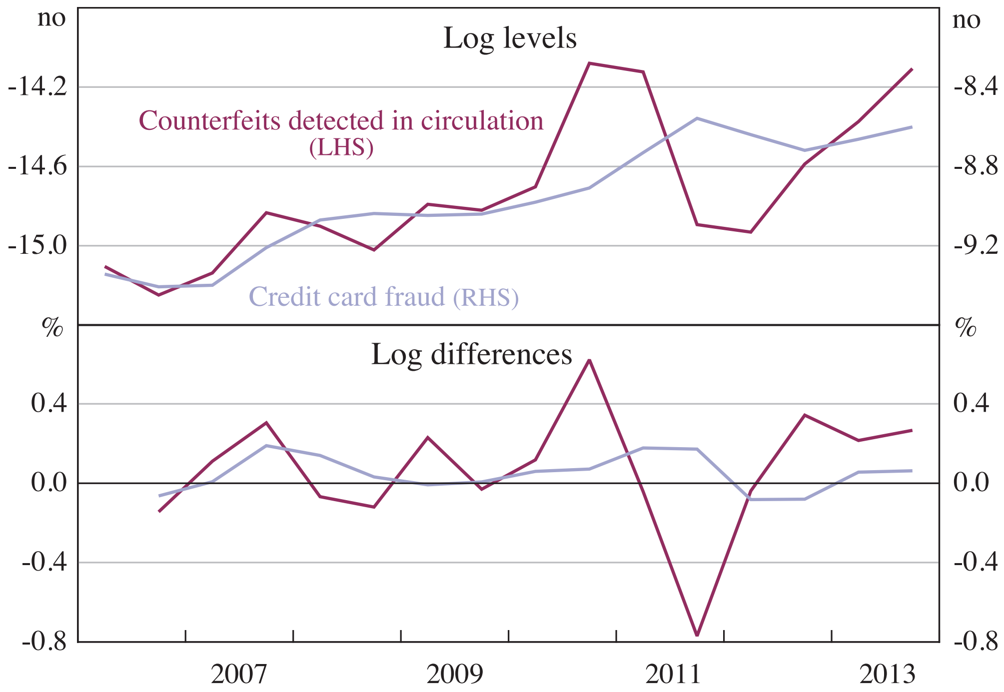
5.2 Credit Card Fraud

It is possible that fraud in other payment mechanisms could affect the identification of the counterfeiting shock in our model. For example, our expectation is that credit card fraud would have a negative effect on credit card use. However, if counterfeiting and credit card fraud are contemporaneously correlated – for example, via a generalised increase in criminal activity of this nature – the positive response of credit card debt to the counterfeiting shock in our model could be biased. A useful thought experiment is to consider the effect of simultaneous shocks to counterfeiting and credit card fraud. We would expect the counterfeiting shock to reduce the demand for banknotes and increase the aggregate use of credit cards, while the credit card fraud shock would reduce the aggregate use of credit cards. To the extent that counterfeiting and credit card fraud are found to be contemporaneously correlated, the impulse response functions in Figure 3 could be negatively biased.

The Australian Payments Clearing Association (APCA) publishes year-ended data on credit card fraud for every financial year and calendar year. There are 16 observations in the data between June 2006 and December 2013, which does not provide enough degrees of freedom for use as a separate endogenous variable in the structural VAR model. While this would enable separate identification of counterfeiting shocks and credit card fraud shocks and could perhaps produce unbiased estimates, the credit card fraud data upon first inspection appears to lag counterfeiting activity in both log levels and log differences (Figures 5 and 6). While this relationship between counterfeiting and credit card fraud is most likely spurious, we mention it here to support our model identification assumption of the counterfeiting shock.

Figure 5: Credit Card Fraud and Counterfeiting

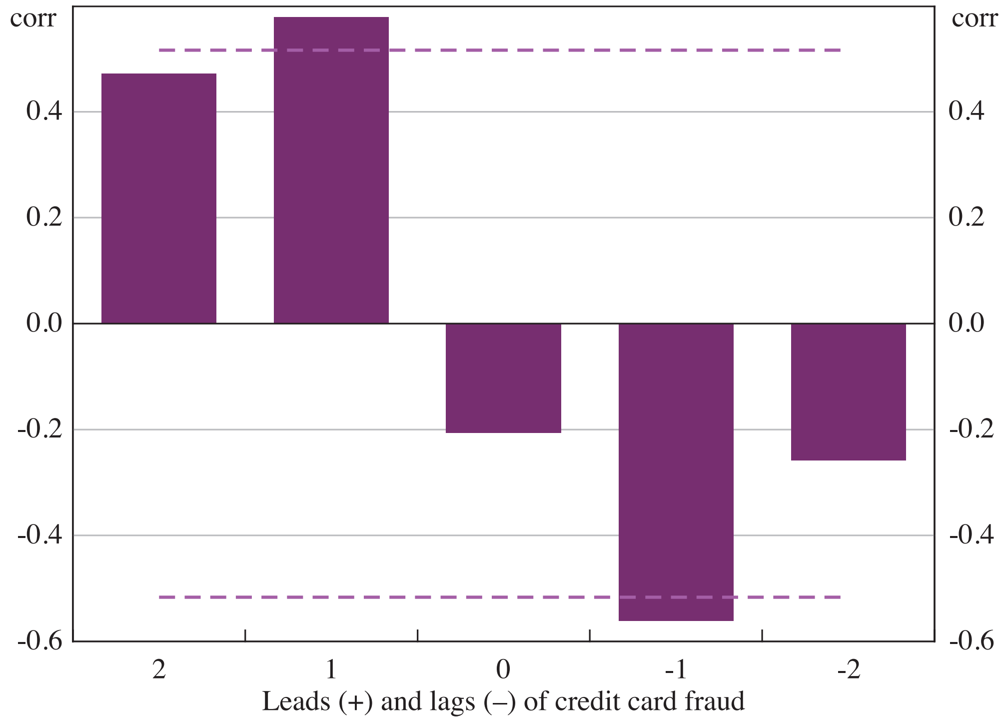
Rolling year-ended sum, normalised by nominal GDP



Sources: APCA; Authors' calculations; RBA

Figure 6: Cross-correlation – Credit Card Fraud and Counterfeiting

Rolling year-ended sum, log differences



Notes: Variables normalised by nominal GDP; dashed lines are the approximate two standard error bounds

Sources: APCA; Authors' calculations; RBA

6. Conclusion

While the level of counterfeiting activity seen in Australia is relatively low, the potential costs to society from counterfeiting are non-trivial. Estimates from a structural VAR suggest that increased counterfeiting activity affects the methods of payment used by the public. The demand for banknotes is found to decline following a counterfeiting shock, consistent with a loss of confidence in the currency. The stock of bank deposits and the stock of credit card debt are found to increase, which is consistent with the public substituting cash for other payment methods.

Using separate data on the cost of making payments, we examine a scenario where cash and electronic card activity follows the response functions estimated by our structural model. This scenario suggests a total increase of A$7.0 million in social costs in response to a total increase in counterfeiting of around A$140 000 spread over a ten-year period. There is substantial statistical uncertainty surrounding the estimates and so they should be interpreted with caution. Even so, the results suggest that there are significant pay-offs from efforts to prevent and deter counterfeiting activity in Australia.

Appendix A: Data

Table A1: Data

Variable	Description	Sources
ATM withdrawals	The value of ATM withdrawals during each quarter	RBA statistical table C4 ATM Cash Withdrawals
Bank deposits	The value of the stock of current bank deposits at banks (including at the RBA) as at the end of each quarter, excluding Australian and State government and inter-bank deposits	RBA statistical table D3 Monetary Aggregates
Banknotes in circulation	The value of currency on issue – holdings by the private non-bank sector as at the end of each quarter	RBA statistical table D3 Monetary Aggregates
Cash rate	The average cash rate in each quarter	RBA statistical table A2 Reserve Bank of Australia – Monetary Policy Changes
Counterfeits detected	The value of counterfeits detected and removed from circulation during each quarter	Australian Federal Police; RBA internal data
Credit card debt	The value of credit and charge card total balances as at the end of each quarter, whether or not incurring interest charges or penalties	RBA statistical table C1 Credit and Charge Card Statistics
Credit card expenditure	The value of purchases made using credit and charge cards during each quarter to obtain goods and services, other than cash advances	RBA statistical table C1 Credit and Charge Card Statistics
Credit card fraud	Scheme credit, debit and charge card fraud perpetrated in Australia and internationally on Australia-issued cards	Australian Payments Clearing Association – Fraud Statistics
Debit card expenditure	The value of purchases made using debit cards during each quarter to obtain goods and services, excluding cash-out components of transactions	RBA statistical table C5 Debit Card Statistics
Media reports	The number of media articles reporting currency counterfeiting detected in each quarter in the Factiva media database	Factiva media database
Nominal GDP	Nominal gross domestic product measured in current prices and seasonally adjusted	ABS Cat No 5206.0
Savings rate	Household saving ratio, seasonally adjusted	ABS Cat No 5206.0

Appendix B: Alternative Model

This appendix contains the results of a structural vector error correction model (VECM) using the same endogenous, exogenous and dummy variables as the baseline model in the main text. The results suggest that the estimates of the baseline model are conservative. In contrast to the baseline model, we find that the response of bank deposits to the counterfeiting shock is statistically significant and much larger. The response of banknotes in circulation and credit card debt are not statistically different to the baseline estimates.

The structural VECM estimates both the short-run and the long-run dynamics of the relationship between the endogenous variables:

$$\mathbf{A}_0 \Delta Y_t = -\alpha\beta' Y_{t-1} + \sum_{j=1}^{J} \mathbf{A}_j \Delta Y_{t-j} + \gamma_0 X_t + \varepsilon_t$$

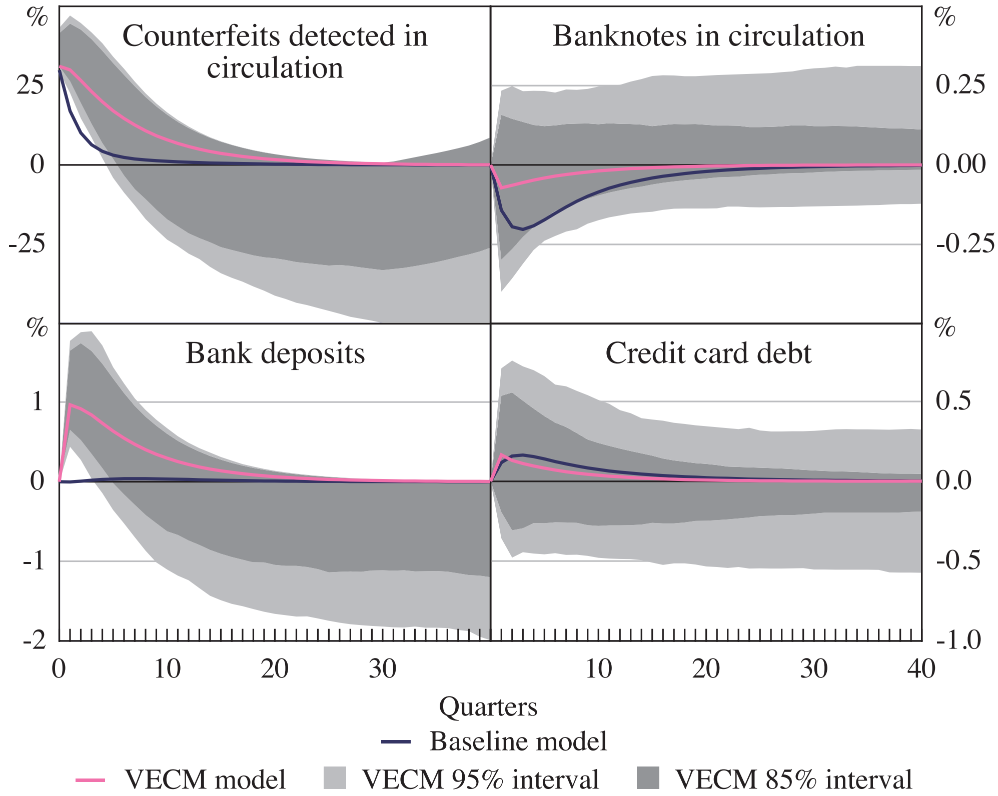
Y_t is the vector of endogenous variables and X_t is the vector of exogenous variables. $\mathbf{A}_j$ are matrices of coefficients for each lag, j, of the endogenous variables governing short-run dynamics. γ_0 captures the contemporaneous effect of the exogenous variables in each equation in the system. β is a single cointegrating vector governing the long-run equilibrium in the endogenous variables. α is a vector of speed of adjustment parameters that measure the speed with which endogenous variables return to the long-run equilibrium. The matrix $\mathbf{A}_0$ contains information governing the contemporaneous relationships between the endogenous variables. The vector of equation residuals, ε_t, are the structural shocks to the system.

The four endogenous variables are normalised by nominal GDP and enter the model in logs. The cash rate enters the model in its level as the single exogenous variable. Dummy variables account for seasonality effects and the effects of the global financial crisis. We identify counterfeiting shocks using the same recursive-ordering identification assumption as in the baseline model. We also assume that the counterfeiting shock does not have long-run effects on the other endogenous variables using restrictions on the α vector.

In contrast to the baseline model, the impulse response estimate for bank deposits is statistically significant and much larger (Figure B1). The response of banknotes in circulation to the counterfeiting shock is smaller in magnitude compared to the baseline, and the response of credit card debt is around the same magnitude, but neither are statistically significant. These results suggest that the estimates of the baseline model are conservative.

Figure B1: VECM Impulse Response Functions

Response to counterfeiting shock



Note: Bootstrap confidence intervals using 1 000 replications

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