Understanding Demand for Australia's Banknotes

Max Wakefield and Richard Finlay[*]

Photo: RBA

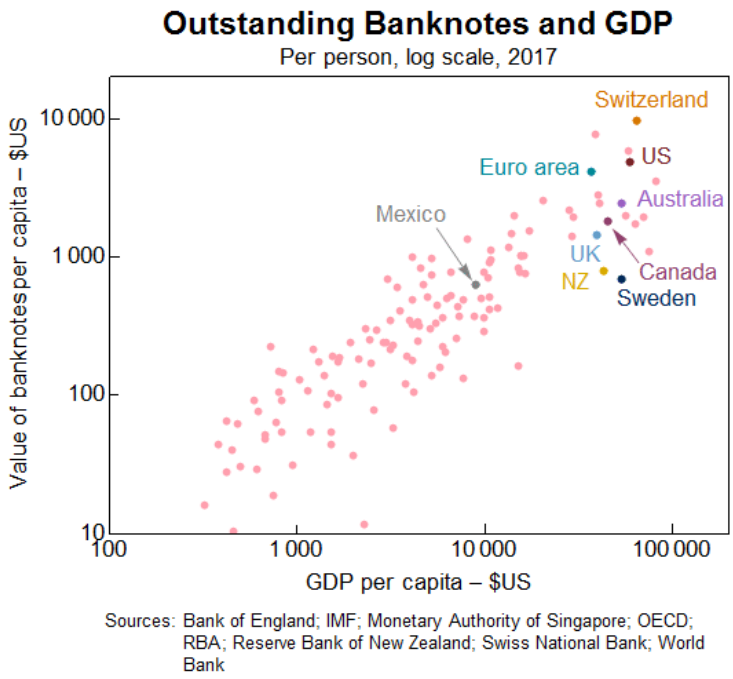
Abstract

As the sole issuer of the nation's banknotes, the Reserve Bank knows how many banknotes it prints, issues to the public and destroys. However, much less is known about how these banknotes are used. This is particularly true for the $50 and $100 banknotes, which, by value, account for more than 90 per cent of banknotes on issue. To help address this, we describe in this article the various components of Australian cash demand and use a range of techniques to estimate how much each category contributes to total demand. Our key findings include that non-transactional demand for cash (e.g. hoarding for store-of-value purposes) has likely been the driving force of recent growth in the value of outstanding banknotes, and that a small but non-trivial portion of cash demand comes from the shadow economy.

Introduction

As at June 2018 the total value of outstanding Australian banknotes was $76 billion, or roughly $3,000 per Australian. Although this figure might seem high, Australia is by no means an outlier amongst other comparable countries (Graph 1). The vast majority of the value of these outstanding banknotes – 93 per cent – is accounted for by the $50 and $100 denominations, split roughly evenly between the two. By contrast, $5 banknotes represent just 1 per cent of outstanding value, $10 banknotes represent 2 per cent and $20 banknotes represent 4 per cent. (By number, the lower three denominations constitute a higher share at around 30 per cent of total banknotes outstanding.)

Graph 1



Sources: Bank of England; IMF; Monetary Authority of Singapore; OECD; RBA; Reserve Bank of New Zealand; Swiss National Bank; World Bank

The value of banknotes on issue has continued to grow over recent years despite a shift away from cash as a means of payment, a phenomenon observed in many countries.[1] To explain these diverging trends, it has been argued that the share of cash used for non-transactional purposes, particularly as a store of value, must be increasing.[2]

This article seeks to investigate the sources of demand for Australian banknotes. This is a worthwhile exercise for a few reasons. Different sources of demand may be affected by different variables and so, understanding the relative importance of each, may help in forecasting overall future banknote

demand, thereby assisting with banknote print orders for example. The use of banknotes to facilitate illegal activity and avoid tax obligations has also been widely discussed in Australia and internationally in recent years, including in the final report of the Black Economy Taskforce (BETF 2017), and we aim to contribute to this discussion by providing estimates of the amount of cash used in Australia's shadow economy.

At any point in time, outstanding banknotes can be considered to fall into one of the following categories:

1. banknotes that, while still recorded as outstanding, have actually been lost or destroyed;
2. banknotes used to facilitate legitimate day-to-day transactions in Australia;
3. banknotes that are held, either domestically or overseas, as a store of value, for emergency liquidity, or for other such purposes (referred to as hoarding); and
4. banknotes used in the shadow economy (either to conceal legal transactions to avoid tax, to pay for illegal goods or to store wealth generated by the sale of illegal goods).

While individual banknotes move between these categories every day, the share of banknotes committed to each category is likely to be relatively stable over the short run and we aim to estimate these shares. It is important to acknowledge, however, that cash is anonymous and hard to trace. Thus, any attempt to estimate where outstanding banknotes are and what they are used for, including that made here, is bound to be an approximation at best. To mitigate this, where possible, we use a variety of techniques to estimate the same quantity, with the hope that if the errors of each technique are imperfectly correlated, then the range of estimates produced will provide a better indication of the truth than any individual method could.

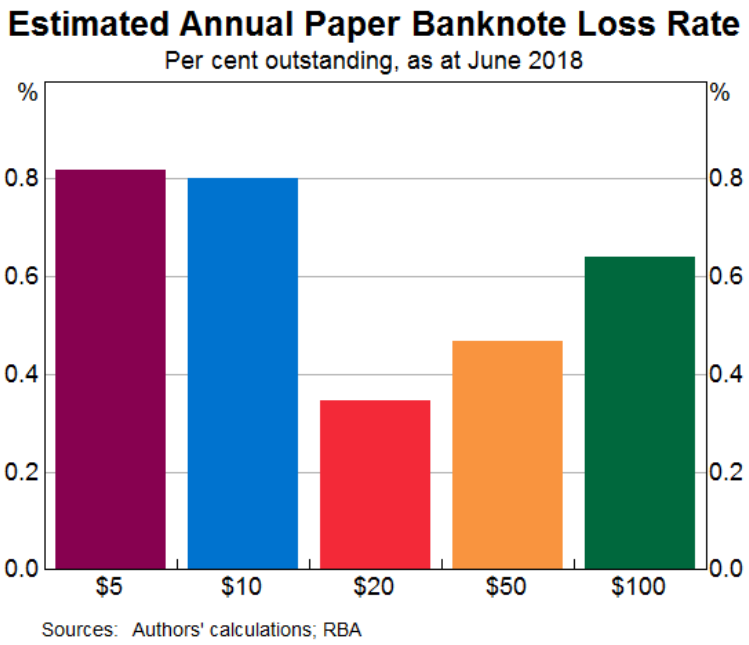
Lost Banknotes

A certain portion of banknotes, while still recorded as being outstanding, are likely to have been lost, destroyed, forgotten about, or are sitting in numismatic collections and otherwise unavailable for spending. For the purposes of this article, we will refer to all such banknotes as 'lost'. To estimate the value of lost banknotes, we assume that all still-outstanding paper banknotes – which were last issued more than 20 years ago – are lost, calculate an implied annual loss rate, and then apply this rate to outstanding polymer banknotes.

Graph 2 shows estimated annual paper loss rates for currently issued denominations (loss rates for paper $1 and $2 banknotes are much higher, at around 4 and 2 per cent respectively). A couple of features are worth noting. First, for low-denomination banknotes (less than $50), there is a rough

inverse relationship between the value of the banknote and the loss rate. This makes sense: people are likely to show greater care towards banknotes of greater value. For high-denomination banknotes ($50 and $100) we see the opposite: the relationship between the value of the banknote and the loss rate is positive. This is most easily explained by hoarding: these banknotes are likely either still hoarded, or have been forgotten about or lost during the hoarding process.

Graph 2



While the loss rates of paper banknotes serve as an indicator for polymer banknotes, there are some important reasons why they may differ. For example, polymer banknotes are more durable than paper banknotes, which suggests that they should be inadvertently destroyed less often. On the other hand, increased international travel has probably resulted in a greater flow of Australian banknotes leaving the country in recent years. Some of these banknotes are unlikely to return. As it is difficult to know the net effect of these factors, we use the minimum and maximum loss rates of the paper denominations to estimate a loss range. Applying these to polymer banknotes suggests that $4–8 billion, or roughly 5–10 per cent of all banknotes on issue, have been lost, destroyed, forgotten about or are sitting in numismatic collections.

Cash Used in Legitimate Transactions

The most visible source of banknote demand is for banknotes that are used to facilitate legitimate transactions in Australia, which we call 'transactional demand'. These are the banknotes that

Australians use daily to purchase goods and services. Transactional demand is also the easiest to estimate since transactional banknotes continuously flow through the cash distribution system. As a result, we are able to employ a number of different methods to estimate the size of this source of demand. Most of our methods distinguish between cash used for legitimate transactions and cash used for shadow-economy activity, although some do not, and where this is the case we adjust our numbers by subtracting estimates of the share of banknotes used transactionally in the shadow economy (5 per cent). We first describe each method and then present a summary of our combined results at the end of this section.

The counting method

Our first approach is to estimate the stock of cash held in various physical locations that are part of the transactional stock, including banknotes in wallets, ATMs and bank branches, cash depots, tills and self-service checkouts and gaming machines, and banknotes held by tourists. These figures are added up to form an economy-wide estimate. This calculation by necessity relies on a number of assumptions, and will miss any cash held in locations not directly considered. Despite these limitations, the approach is useful as it provides a broad sense-check on other estimates arrived at through more abstract means and also offers a tangible basis from which to think about the transactional stock of cash.

We use two approaches to estimate the stock of cash held in each of these locations:

- estimating the number of a given location (e.g. the number of tills) and multiplying this by an estimated average amount held per location; and
- converting flow data to a stock by making assumptions about the velocity of cash through a particular location.

This method suggests that the transactional stock of cash has risen from around $9 billion at the end of 2002 to around $13 billion as at June 2018. This corresponds to an annualised growth rate of around 2 per cent, which is well below the 6 per cent growth rate in total outstanding banknotes over the same period. As a result, the transactional stock's share of the total is estimated to have fallen from 30 per cent to around 20 per cent according to this method (Graph 7).

The banknote life method and the banknote processing methods

We now assume that the non-transactional stock of cash consists only of hoarded $50 and $100 banknotes. While this may not be exactly true, it is probably not far off the mark: for example, almost all large claims for damaged banknotes that are submitted to the Reserve Bank are for the $50 and

$100 denominations. We then try to find some data affected by this hoarding. In each of the methods below, this involves data where the $50 and $100 banknotes behave very differently to the other denominations. This difference can then be used to estimate transactional demand for the $50 and $100. Adding this to the value of outstanding $5, $10 and $20 banknotes, less our estimates of lost banknotes, gives an estimate of overall transactional demand. (Note that neither of these methods will distinguish between banknotes used for legal and shadow-economy transactions.)

The banknote life method

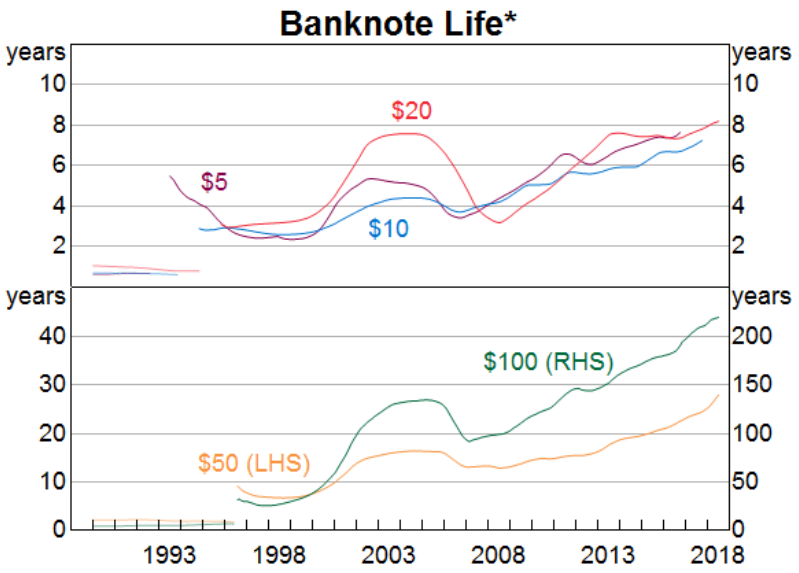
Banknotes reach the end of their lives (become 'unfit') for two main reasons: excessive inkwear, which will tend to increase in a relatively linear fashion with banknote use; and mechanical defects such as tears, which can be thought of as random events that can occur at any stage, but whose cumulative probability of having occurred also increases with use. Given that all denominations of banknotes are initially of similar quality, the speed at which certain denominations become unfit is closely related to the frequency with which they are handled. Since banknotes are most commonly handled when used as a means of payment, banknotes used in transactions should have a shorter lifespan than banknotes not used in transactions.

Graph 3 shows estimated banknote life, from which one can observe that: polymer banknotes have a much longer lifespan than paper banknotes; low-denomination banknotes ($5, $10, and $20) have broadly similar banknote lives; and high-denomination banknotes ($50 and $100) have a longer lifespan than low-denomination banknotes.[3] Further, one can see that the lifespan of all banknotes has increased in recent years, which could reflect improvements in banknote handling; a decline in the velocity of transactional cash; and/or the after-effects of previous banknote cleansing programs, which replaced unfit banknotes with new ones, reducing measured banknote life at the time and increasing the quality (and remaining life) of the outstanding stock. Finally, we note that low-denomination banknotes all having similar lifespans supports the assumption that most hoarding occurs with high-denomination banknotes. For example, if the $20 was hoarded significantly more than the $10, we would expect that to show up in a longer life for $20 banknotes, whereas this is not the case.

If we assume that all banknotes used in transactions wear out at a similar rate, then the 'excess life' of high-denomination banknotes relative to low-denomination banknotes can be attributed to hoarding. Based on this insight, we estimate that over the past three decades, the share of $100 banknotes used for transactions has fallen from around 20 per cent to just 3 per cent; the share of $50 banknotes used for transactions has fallen from around 35 per cent to 25 per cent; and the

transactional share by value of all banknotes has fallen from around 45 per cent to around 20 per cent, or 15 per cent after subtracting our estimate of cash used in the shadow economy (Graph 7).

Graph 3



* Initial data are paper, later data are polymer; excludes periods when issuance of new series banknotes materially affected data; banknote distribution arrangements were changed in the early 2000s, resulting in a large stock of banknotes entering circulation and temporarily boosting estimated life

Sources: Authors' calculations; RBA

The banknote processing method

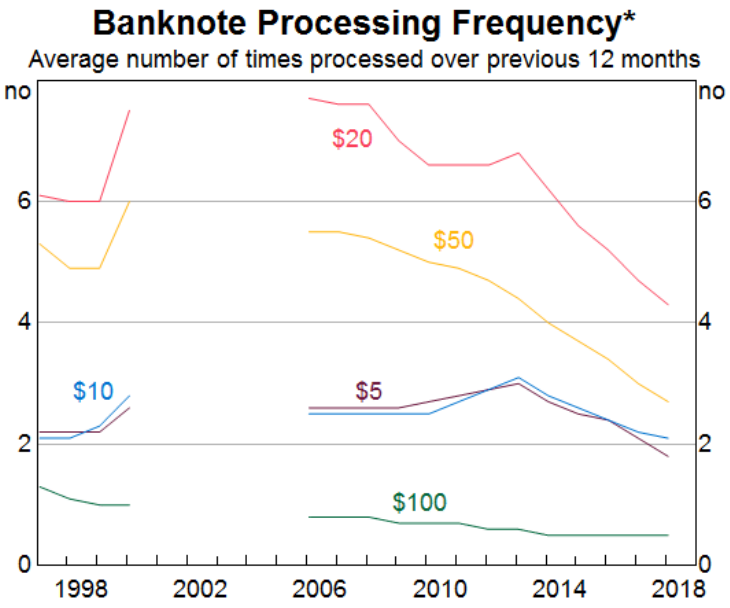
One can apply the same idea to data on the frequency with which different banknote denominations are processed by cash depots. In particular, cash depots process and fitness-sort banknotes lodged by commercial banks and large retailers, but do not process any banknotes that are hoarded or otherwise are not part of the transactional stock of cash. Thus, broadly speaking, only the transactional stock of banknotes passes through cash depots, and the rate at which banknotes pass through depots is an indication of transactional cash use.

Graph 4 shows the average number of times each banknote denomination passes through a cash depot per year. A few features are worth observing. First, in recent years there has been a general decline in the processing frequencies of all denominations. This is consistent with a fall in the speed with which cash flows through the economy and/or consumers substituting away from cash as a means of payment, both of which result in banknotes passing through depots less frequently. Second, we see that the $50 and $100 banknotes pass through depots less frequently than $20 banknotes, which is indicative of non-transactional demand for these denominations given that,

once spent, they are very likely to be banked (retailers don't keep $100 banknotes to use as change). Conversely, the low processing frequency of the $5 and $10 banknotes is most likely due to their use as change – that is, they cycle between consumers and retailers many times before being returned to a cash depot for processing.

Given this, if we assume that the processing frequency of *transactional* $50 and $100 banknotes is equal to the processing frequency of the $20 banknote, then the difference between the *observed* processing frequency of $50 and $100 banknotes and that of the $20 is the result of hoarding. In fact the true processing frequency of transactional $50 and $100 banknotes is likely to be higher than the $20 denomination as almost all $50 and $100 banknotes received by retailers will be banked, whereas some $20 banknotes will be given as change. This suggests that this method will deliver an upwardly biased transactional share estimate.

Graph 4



* Excludes periods when changes in banknote distribution arrangements materially affected the data; data either side of the break are not directly comparable

Sources: Authors' calculations; RBA

Applying the same technique used in the banknote life calculations suggests that the transactional stock has fallen from around 55 per cent of total outstanding banknotes in the late 1990s to around 40 per cent now (or 35 per cent after subtracting cash used in shadow-economy transactions; Graph 7).

The velocity method

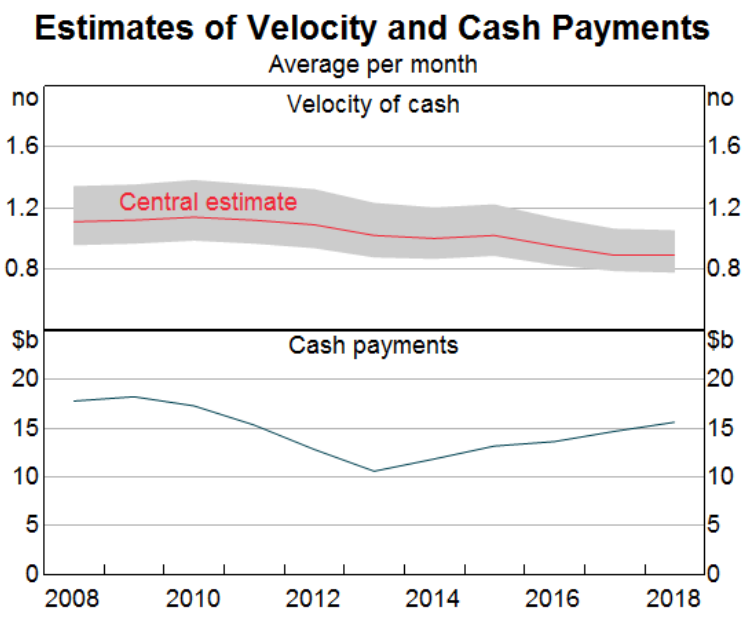
Another way to estimate the stock of cash used for transactions is to first estimate the flow of cash payments made by consumers, and then convert this flow into a stock. The flow of cash payments and the stock of banknotes used to make them are related, but one banknote can be used in multiple transactions; banknote velocity ties the two concepts together, as described in Equation 1 below.

Equation 1

$$Flow\ of\ cash\ payments = Velocity\ of\ transactional\ stock \times Value\ of\ transactional\ stock.$$

We estimate the flow of cash payments through time by scaling the value of card payments with the cash-to-card payment ratio as recorded periodically in the Reserve Bank's Consumer Payment Survey (CPS; Graph 5).[4] To estimate the velocity of transactional cash, we map out the cash cycle: banknotes start at a cash depot, are transported to an ATM or bank branch, pass to a consumer's wallet or purse, get spent at a business, and then get returned to a bank and/or cash depot. For some legs of this journey we have accurate data – for example, we know the flow into and out of cash depots, and so can calculate the average time a banknote spends in a depot – whereas for other aspects we need to use judgement. Because of this, we estimate a range for the velocity of cash rather than a single number (Graph 5). Our estimates suggest that the velocity of transactional cash has declined over the past decade, and that, on average, a transactional banknote takes a little over one month to complete a full cycle.

Graph 5



Sources: Authors' calculations, based on data from Colmar Brunton, Ipsos, RBA and Roy Morgan Research; Tourism Research Australia

To estimate the transactional stock of cash we divide our estimates of cash payments by our estimates of velocity. With cash payments estimated to be broadly stable and velocity estimated to be falling, we estimate the transactional stock to be gradually increasing over recent years and in the range of $15–25 billion currently. These results suggest that transactional cash accounts for around 20–30 per cent of total outstanding banknotes (Graph 7).

The seasonality method

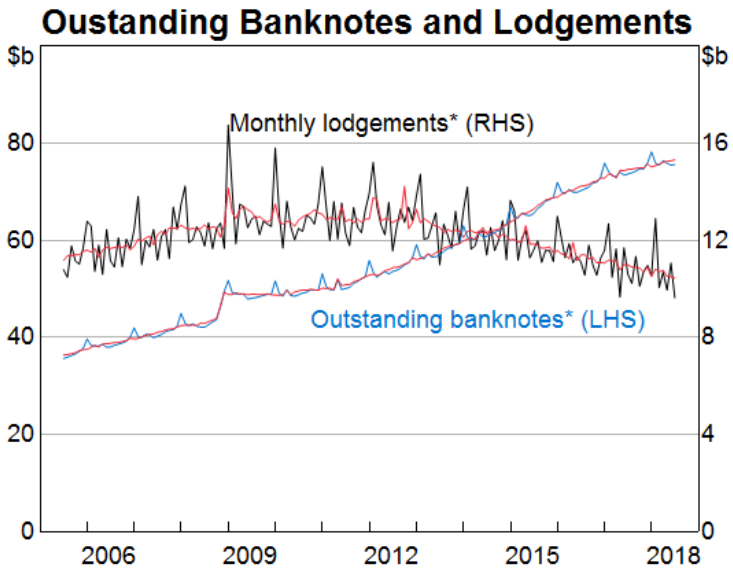
The final way we estimate the transactional share of banknotes is via the seasonality present in banknote demand. The logic works as follows: demand for cash displays a predictable seasonal pattern, with a peak around Christmas and a trough in the winter months. This seasonality resembles that of consumer spending, which suggests that it is driven by seasonality in transactional cash demand. On the other hand, non-transactional cash demand (for example, hoarding for store-of-value or numismatic purposes) is unlikely to contain significant seasonality. As a result, if most cash is transactional, then the seasonality of cash demand should closely match the seasonality of cash spending; conversely, if non-transactional demand is more important, then there will be less seasonality in cash demand than in spending. As such, and similar to the banknote life and banknote processing methods, the degree of seasonality present in cash demand, when

compared with the seasonality of cash spending, is an indication of the share of cash used for transactional purposes.

Graph 6 shows original and seasonally adjusted data for the stock of outstanding banknotes, as well as the monthly flow of banknote lodgements to cash depots – the latter being a proxy for cash spending.[5] The degree of seasonality in each series can be seen in the extent to which the 'original' line deviates from the 'seasonally adjusted' line; it is clear that cash lodgements are the more seasonal series.

To account for the stock/flow mismatch between outstanding banknotes and cash lodgements, we adjust the seasonality of the lodgement data with three estimates of the seasonality present in the velocity of transactional cash, and then average over the three estimates.[6] Our results suggest the transactional stock of cash has been largely unchanged over the past decade. Converting to a share of total banknotes outstanding suggests that transactional demand has declined from around 40 per cent of outstanding banknotes in 2009 to 25 per cent currently, or 20 per cent after subtracting cash used in shadow-economy transactions (Graph 7).

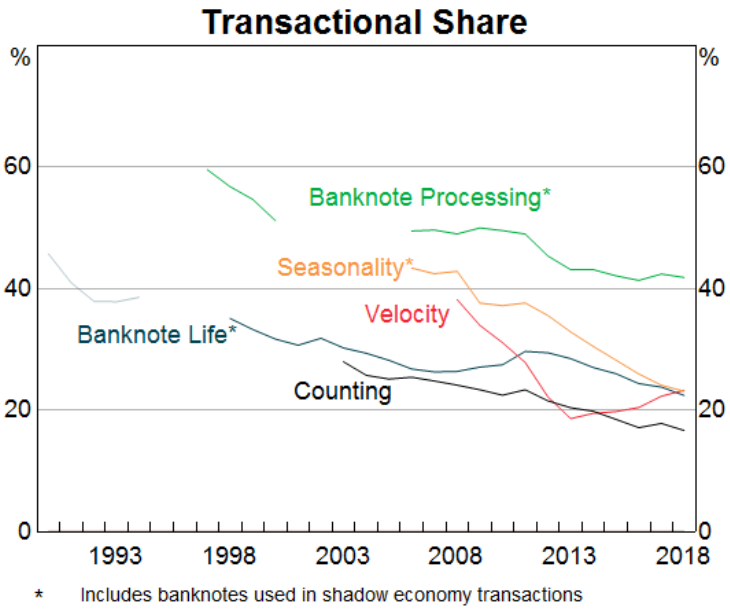
Graph 6



Overview of cash used in legitimate transactions

Overall, the methods that we employ suggest that somewhere between 15 and 35 per cent of outstanding banknotes are used to facilitate non shadow-economy transactions within Australia (Graph 7). Notably, all methods show that this share is in decline. Although each estimation method is imperfect, we take comfort from the fact that a number of different methods yield a broadly similar trend.

Graph 7



Hoarding

Another major component of currency demand is hoarding, which can be done either by Australian residents (domestic hoarding) or by foreigners (international hoarding). Hoarding refers to banknotes actively held by people for reasons other than to finance everyday payments, and so excludes the transactional stock of banknotes (both legitimate and shadow economy), and banknotes that have been lost. Evidence from the 2016 CPS suggests that around 70 per cent of Australians hold cash outside of their wallets, and that they do so for a variety of reasons, including as a store of wealth, for use in emergencies, a desire for privacy and as a back-up in case of problems with electronic payment systems. The existence of asset means-testing for various social benefits in Australia, and more generally the desire to hide assets from tax authorities, also provides an incentive for Australians to hold assets in a form that is hard to trace.

Estimates of total hoarding: the residual

While we presented the banknote life, banknote processing and seasonality estimates above as indirect estimates of transactional cash demand, they can equally be seen as indirect estimates of hoarding demand. For instance, the banknote life method suggested that 20–40 per cent of outstanding banknotes were used to facilitate transactions (legal and shadow economy), implying that 60–80 per cent are used for non-transactional purposes. Subtracting our estimates of lost banknotes (5–10 per cent) suggests hoarding in the range of roughly half to three-quarters of total outstanding banknotes. The other indirect estimates of transactional demand give broadly similar results.

Domestic hoarding

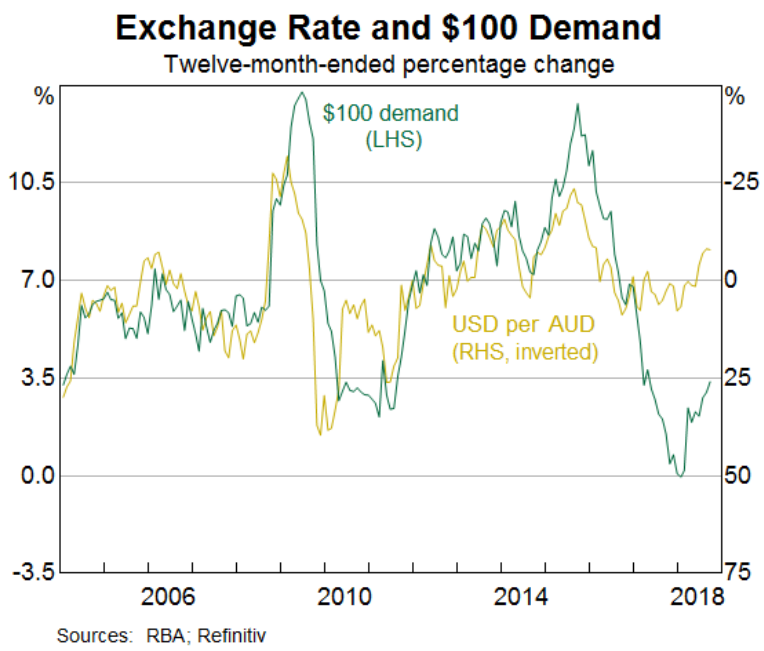
In the 2013 and 2016 CPSs, respondents were asked to select a range that described the amount of cash they held outside their wallets. Scaling these results to economy-wide levels, we estimate that domestic cash hoarding is in the range of roughly 10–20 per cent of total outstanding banknotes.[7] While this represents a material share of Australian banknotes, it is still likely to be an underestimate. This is because those with large physical cash holdings are probably less likely to participate in a survey than others and, even if they do, might be hesitant to respond with the true extent of their cash holdings.

International hoarding

The Bank has previously noted that foreign demand for banknotes is an increasingly important component of currency demand, both in Australia and overseas (Flannigan and Parsons 2018). This is highlighted by a historically strong relationship between the exchange rate and demand for $100 banknotes: depreciations in the Australian dollar are associated with an increase in demand, although the relationship appears to have weakened somewhat of late (Graph 8).

To estimate overseas hoarding, we first estimate the value of Australian banknotes flowing out of Australia; such outflows can occur via a number of channels, although the most significant appears to be international wholesale currency shipments that transport Australian banknotes to foreign banks and bureaux de change. From this gross outflow, we deduct an estimate of Australian currency that re-enters Australia; the largest component here is banknotes brought back into Australia by tourists, which we estimate as total tourist spending in Australia less the estimated portion of spending done using electronic means of payment or via banknotes obtained in Australia.

Graph 8



There is considerable judgement involved in these calculations, and reasonable assumptions lead to an estimate of net banknote outflows over the past decade (i.e. additions to the stock of internationally hoarded Australian banknotes) of between zero and 15 per cent of total outstanding banknotes. It is important to note, however, that even this large range could be wrong as it is calculated as the residual of two imprecisely estimated quantities.

Overall assessment of hoarding

Overall, we estimate that between half and three-quarters of the value of outstanding banknotes are hoarded in some form. Of this, we can attribute 10–20 percentage points to domestic hoarding and up to 15 percentage points to international hoarding. However, this does not necessarily mean that total hoarding is overestimated. As discussed, there are limitations to the estimates of domestic and international hoarding. In particular, domestic hoarding is likely to be higher than estimated, while international hoarding could also be higher.

Banknotes Used in the Shadow Economy

A source of currency demand that continues to attract considerable attention in Australia and internationally is the use of cash to facilitate activity in the 'shadow' or 'black' economy. Borrowing from the Australian Bureau of Statistics (ABS, 2013) we define the shadow economy as consisting of:

- underground production (the deliberate concealment of legal activities to avoid tax payments); and
- illegal production (activities forbidden by law where there is mutual consent, such as illegal drug production and sale).

To estimate the stock of banknotes used in the shadow economy, we first estimate the size of the shadow economy (a flow of spending) and then use our estimate of banknote velocity to convert this into a stock of cash required to facilitate these transactions. The assumption that most shadow-economy transactions are made with cash is implicit. While this may not be exactly true, it is probably a reasonable approximation of reality.[8]

By its very nature, the shadow economy is difficult to measure. To ensure our results are as robust as possible, we use various estimates of its overall size. Our baseline approach is to scale estimates made in ABS (2013) for 2009/10 to 2017/18 levels. Our second approach is to combine results from the ABS with the Australian Criminal Intelligence Commission's (ACIC) estimates of the size of the illicit drug market in Australia. In both methods we assume that the only material component of illegal production is illegal drug production; this may downwardly bias our estimates slightly, although illegal drug production is likely to be the largest component of total illegal production by some margin (the ABS also took this approach when estimating illegal production for 2009/10).

ABS estimates for 2009/10 applied to 2017/18 GDP figures

ABS (2013) estimated underground production to be 1.5 per cent of nominal GDP and household expenditure on illegal drugs to be 0.8 per cent of total household consumption in 2009/10. In 2017/18, nominal GDP was $1,848 billion, while nominal household consumption was $1,044 billion; applying the same 1.5 and 0.8 per cent estimates as for 2009/10 implies annual underground production of $27½ billion and annual nominal spending on illegal drugs of $8½ billion in 2017/18.

To approximate the quantity of cash required to facilitate shadow-economy activities, we divide the spending figures above by our estimate of banknote velocity and assume that, when a person sources cash to purchase illicit drugs or pay for underground production, they do so in much the same way as when they source cash for other reasons. These estimates imply that $2½ billion of cash, or around 3 per cent of the value of banknotes on issue, is used to facilitate underground production, and that a little less than $1 billion of cash, or just under 1 per cent of the value of banknotes on issue, is used to facilitate illegal production and purchase illicit drugs. That is, we estimate the stock of cash used to facilitate shadow-economy transactions to be around $3½ billion, or 4 per cent of banknotes on issue.

Adjusting to account for the BETF's findings

The BETF's recent report included the assessment that the size of the shadow economy is up to 50 per cent larger than that suggested by ABS (2013).[9] Boosting the estimates above by 50 per cent implies that the stock of cash committed to shadow-economy activities at any particular time is approximately $5 billion, or around 7 per cent of the value of banknotes on issuance.

New estimates of cash used in the drug trade

We next modify these results to incorporate ACIC's estimates of the size of the Australian drug market, which are made via wastewater analysis (see below). This allows us to re-estimate the value of banknotes used to purchase illicit drugs, as well as to estimate the value of cash hoarded by drug suppliers.

Estimates of cash used to purchase illicit drugs

Wastewater analysis is a standard method used to measure drug consumption. The method is based on 'the principle that any given compound that is consumed will subsequently be excreted' (ACIC 2018b) and end up in the sewer system. Calculating the amount of a given compound in wastewater allows for a back-calculation to estimate the amount of drug that was used by the population connected to the wastewater. National estimates of annual drug consumption are then made by scaling the results to population levels.

This method suggests annual illicit drug expenditure of roughly $13½ billion, with methylamphetamine and cannabis accounting for more than 70 per cent of this value. Because a single banknote can make multiple payments, we convert the annual flow of purchases to a stock using our earlier velocity estimates. This suggests that, for the year ending August 2017, the stock of cash used to facilitate purchases of illicit drugs was a little more than $1 billion, or almost 2 per cent of the total value of banknotes on issue.

Estimates of cash held by drug suppliers

Evidence from AFP drug raids suggests that suppliers of illicit drugs often hold large volumes of cash. To estimate total cash held by drug suppliers, we combine our previous estimates of the illicit drug market with data released by the AFP and the ACIC detailing annual cash and drug seizure quantities (ACIC 2017). By comparing the value of cash seized with the value of illicit drugs confiscated, we can estimate how much cash the average drug supplier holds relative to their illicit drug stock. Scaling this number by our estimates of the size of the domestic drug market gives economy-wide estimates of the cash stock hoarded by drug suppliers, although we note that our estimates will only be reliable if those who have drugs and cash seized by the police are representative of all those involved in the illicit drug supply chain.

Data from cash and drug seizures suggests that drug suppliers maintain cash holdings of around 2 per cent of the value of their stock of drugs, on average.[10] By comparison, the same data suggest that seized proceeds of crime (that is, all assets gained through crime, not just cash) equated to approximately 11 per cent of the value of drugs seized. This implies that criminals convert a large share of their cash profits into other assets, and do not solely hoard cash. Combining this with our earlier assumptions suggests that total cash hoarding by the illicit drug supply chain is in the range of $40 million to $1 billion, or somewhere between 0 and 1 per cent of all banknotes on issue.[11]

Overall assessment of cash used in the shadow economy

Our estimates suggest that between roughly $3½ and $6 billion worth of Australian banknotes are used in the shadow economy, split between underground production ($2½–$4 billion), purchases of illegal drugs (around $1 billion), and storing the profits of criminal activity (up to $1 billion). This represents between 4 and 8 per cent of all banknotes on issue.

Conclusion

This article uses a range of techniques to estimate where Australian banknotes are and what they are used for. Our results suggest that of total outstanding banknotes: 5–10 per cent are lost; 15–35 per cent are used to facilitate legitimate transactions; half to three-quarters are hoarded, of which we can allocate 10–20 percentage points to domestic hoarding and up to 15 percentage points to international hoarding; and 4–8 per cent are used in the shadow economy. Our best guess of point estimates for each of the above categories are broadly the midpoints of the ranges given, with the exceptions of the subcategories of hoarding: even the upper estimate of 20 per cent of outstanding banknotes being used for domestic hoarding is likely too low, while international hoarding and the hoarding of profits from criminal activity may also be higher than suggested by the estimation techniques that we employ.

In addition, our results suggest that the share of banknotes used in transactions has fallen by around 1–1½ percentage points per year over the past few decades. This is consistent with the Reserve Bank's CPSs, which show that debit and credit cards have recently overtaken cash as the most frequently used means of payment. Consequently, it is likely that non transactional demand has been the driving force of recent growth in the value of banknotes on issue. Despite constituting a declining *share* of transactions, however, we estimate that the *value* of banknotes used to facilitate legitimate transactions in Australia has increased slightly over recent years, and is currently around $15–20 billion.

Footnotes

[*] The authors are from Note Issue Department; this article summarises a longer paper and interested readers should refer to Finlay, Staib and Wakefield (2018) for further details on the estimation methods employed.

[1] For example Doyle *et al* (2017) document that, in 2016, electronic payments surpassed cash as the most common payment method; we will use the terms 'banknotes', 'currency' and 'cash' interchangeably throughout this paper.

[2] See for example Davies *et al* (2016) and Flannigan and Staib (2017), as well as Flannigan and Parsons (2018) for a comparison of trends in Australia, Canada and the UK.

[3] We measure banknote life as the average number of banknotes outstanding over a given period, divided by the number of banknotes that have been deemed unfit over the same period, and choose a five-year period to average over in order to reduce undue volatility. This is the 'steady-state method' described in Rush (2014).

[4] The card payment data are from RBA Statistical Tables C1 and C5, which are available at <https://www.rba.gov.au/statistics/tables/>. The CPS was conducted in 2007, 2010, 2013 and 2016 and provides the Bank with a nationally representative dataset of the payment habits of Australian consumers; the next survey is planned for 2019. We interpolate between survey years and extrapolate the 2013–16 trend for 2017 and 2018.

[5] We use lodgement data as a proxy rather than card spending data here to avoid possible seasonal variation in consumers' payment preferences, which may mean that the seasonal pattern of card spending differs from that of cash spending.

[6] We approximate the seasonality of velocity as: unchanging (that is, we assume that velocity is non-seasonal); as the seasonality present in the number of ATM withdrawals per person per month; and as the seasonality present in our estimate of velocity presented previously.

[7] The CPS asks respondents to select a bucket that their cash holdings fall into, from '$1–$100' through to 'more than $5,000'. We take the midpoint of each value bucket, or $10,000 for the top, open-ended bucket, as the average hoarding of each respondent within each bucket, and scale up the results to be representative of the adult population. For those who did not answer (2013 and 2016) or chose 'prefer not to answer' (2016 only), we set their cash hoarding as the weighted average of those who did answer. For 2013, we estimate cash hoarding of 20 per

[7] cent of outstanding banknotes, while for 2016 the estimate is lower at roughly 10 per cent, suggesting that a large degree of sampling error exists in these estimates.

[8] For example, despite anecdotal reports suggesting that an increasing number of illicit drug purchases are made online using digital currencies such as bitcoin, survey results from the National Drug and Alcohol Research Centre's Illicit Drug Reporting System (Karlsson and Burns 2017) indicate that most drug users still purchase their drugs face to face.

[9] The difference can, in part, be explained by the BETF including a wider range of shadow-economy activities in their analysis (some of which are unlikely to involve material amounts of cash).

[10] In particular, over the five years to 2016/17, the ACIC reports total drug seizures worth $6.1 billion and total cash seizures of $100 million (ACIC 2017).

[11] See Finlay *et al* (2018) for details of the other assumptions underlying these calculations.

References

ABS (Australian Bureau of Statistics) (2013), 'Information Paper: The Non-Observed Economy and Australia's GDP, 2012', ABS Cat No 5204.0.55.008, viewed 4 July 2018.

ACIC (Australian Criminal Intelligence Commission) (2017), *2016–17 Annual Report*.

ACIC (2018a), *Illicit Drug Data Report 2016–17*.

ACIC (2018b), *National Wastewater Drug Monitoring Program*, Report 4, March.

BETF (Black Economy Taskforce) (2017), *Black Economy Taskforce: Final Report – October 2017*, (M Andrew, Chair), Australian Treasury, Canberra.

Davies C, M-A Doyle, C Fisher and S Nightingale (2016), 'The Future of Cash', RBA *Bulletin*, December, pp 43–52.

Doyle M-A, C Fisher, E Tellez and A Yadav (2017), 'How Australians Pay: Evidence from the 2016 Consumer Payments Survey', RBA Research Discussion Paper No 2017-04.

Finlay R, A Staib and M Wakefield (2018), 'Where's the money? An investigation into the whereabouts and uses of Australian banknotes', RBA Research Discussion Paper No 2018-12.

Flannigan G and S Parsons (2018), 'High-Denomination Banknotes in Circulation: A Cross-Country Analysis', RBA *Bulletin*, March, viewed 4 July 2018. Available at <https://www.rba.gov.au/publications/bulletin/2018/mar/high-denomination-banknotes-in-circulation-a-cross-country-analysis.html>.

Flannigan G and A Staib (2017), 'The Growing Demand for Cash', RBA *Bulletin*, September, pp 63–74.

Karlsson A and L Burns (2017), *Australian Drug Trends 2017: Findings from the Illicit Drug Reporting System (IDRS)*, Australian Drug Trends Series No 181, National Drug and Alcohol Research Centre, Sydney. Available at <https://ndarc.med.unsw.edu.au/resource/illicit-drug-reporting-system-idrs-national-report-2017>.

Rush A (2015), 'The Life of Australian Banknotes', RBA Research Discussion Paper No 2015-10.