

Negative Interest Rates and the Demand for Cash

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Abstract

Switzerland, Denmark, and Sweden and the euro countries of Europe have all imposed small negative interest rates on deposits commercial banks place with their central bank. These costs may be passed on to their depositors in the form of a fee on deposit balances. The fear is that higher negative interest rates will provide an incentive for banks and depositors to increase their demand for cash. If this occurs, banks may hoard cash and depositors may substitute cash for card transactions. A number of solutions have been proposed but have administrative and political drawbacks. Current operating procedures offer a less disruptive approach.

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Negative interest rates, long thought to be either impossible or only a temporary aberration, are now found in a number of countries. We outline how the demand for cash may expand if negative interest rates rise further and illustrate its possible effect on the use of cards at the point of sale. Other effects on payment arrangements are also possible but of less importance.

Negative interest rates are expected to have a positive effect on a country's aggregate demand and/or its foreign exchange rate, which is why monetary authorities currently favor them. Various solutions exist to deal with the effect of negative rates on the demand for cash but they are either considered politically controversial or administratively difficult. We end by noting how the demand for cash may be contained using current operating procedures. Our numerical illustrations use U.S. data, due to its public availability, but the analysis and conclusions apply equally to other countries.

1 Negative Interest Rates can Increase the Demand for Cash.

When negative interest rates are imposed on balances banks hold with their central bank, banks have a number of alternatives. Some banks may move a portion of their taxed balances into new domestic loans which can stimulate aggregate demand, which is one goal of negative rates. Others may purchase domestic government securities, draining reserves from the banking system. Still other banks, at the direction of their depositors, may purchase foreign short-term securities or other foreign assets and, if large enough, depreciate the exchange rate (stimulating their export sector and thus aggregate demand). Or if actual depreciation is not the goal, the movement of funds to another country would enable the country to maintain its exchange rate with an important trading partner. This has been the apparent goal of Switzerland, Denmark, and Sweden.¹

Still other banks may simply reduce their taxed central bank balance by withdrawing cash. This is the case that concerns monetary authorities the most since cash withdrawn and held idle does not generate new loans that could stimulate the economy. In any case, the portion of a bank's balance at the central bank that is taxed may exclude required reserves, balances used to clear transactions, and certainly reserves associated with quantitative easing. The main focus of this paper concerns negative interest rates imposed on "excess reserves" which can provide an incentive for banks to hold additional vault cash rather than pay the central bank fee. Cash is not subject to a negative interest rate once it is withdrawn from the central bank. If the cost to banks of holding central bank balances is passed on to the bank's depositors—say in the form of a fee on the value of deposits held—then depositors too would have an incentive to hold more cash for both transactions and savings.

In practice, such a substitution has already occurred in countries that impose reserve requirements that either earn no interest or less than a market return on reserves held

¹Since one bank's purchase of securities or debiting its reserve balance means that another bank is receiving a credit to its reserve balance, the central bank has to facilitate the draining of reserves from the banking system. This is consistent with imposing negative interest rates to lower reserves in the first place.

with the central bank. In the U.S., the long-standing 10% reserve requirement on transaction balances is (or should be) included in the monthly account maintenance fee that banks charge both consumers and businesses. The reserve requirement also affects the calculation of the earnings credit rate given to firms and other banks for the collected idle balances they hold as compensation for services used by consumers and businesses (payment clearing, cash management, payroll administration, currency provision, and safekeeping).

If negative interest rates lead banks to raise fees on deposit balances, some depositors may respond by holding more cash. If the increased cash is used for transactions (typically at the point-of-sale), card and/or check payments will fall. As well, some local bill payments could shift to cash and away from card, check, ACH or giro transactions.

An incentive for large depositors to hold more cash would also exist. However, these depositors are likely to weigh the extra (transportation, storage, and insurance) costs of holding more cash against the higher fee and the returns from holding alternative liquid assets (government securities, commercial paper, etc.), along with the associated operational expense of managing these assets to ensure that working capital liquidity is not impaired. Large corporations, through their treasury operations, already go to great lengths to minimize their deposit balances and hold earning assets instead.

In sum, only banks withdrawing cash from their central bank balance and consumers withdrawing cash from bank ATMs (or over the counter at branches) would markedly contribute to the rise in the demand for cash following negative interest rates. Businesses, particularly retailers, are (overall) net depositors of cash and so are not the source of the cash demand problem. Bank and consumer cash withdrawals and deposits in the U.S. are illustrated in Figure 1. The top of the figure shows the value of cash deposits and withdrawals by banks with the Federal Reserve while the bottom shows consumer withdrawals from ATMs and over-the-counter (mostly by businesses, not consumers). These cash flows, of course, serve to maintain the value of the \$1.13 trillion of cash in circulation.²

(Insert Figure 1 here)

What if U.S. consumers withdrew \$50 more than the average \$118 they now do each time they went to the ATM in response to a higher fee on their bank deposit balance? If the entire extra \$50 replaced electronic card transactions at the point-of-sale, card usage would fall by \$290 billion.³ Since the value of card point-of-sale transactions is \$3 trillion,⁴ the value of card point-of-sale transactions would fall by 10%. As the U.S. domestic stock of cash is \$636 billion, a \$50 rise in the value of each ATM cash withdrawal would raise the demand for cash by 11% (\$71 billion).⁵ Depending on the inventory of cash at the central bank, the Bureau of Printing and Engraving could be

²Only \$636 billion (56%) is believed to circulate domestically. The rest, \$492 billion, is held outside the U.S. (Board of Governors of the Federal Reserve System, 2015, Table L.204, line 35).

³There are 5.8 billion ATM transactions per year so withdrawing \$50 extra for each transaction means that an extra \$290 billion would be withdrawn.

⁴Debit and credit cards issued by various networks can be used at the point-of-sale as well as stored-value and private label cards. The total value of these card transactions at the point-of-sale was \$2.98 trillion in 2012 (Federal Reserve System, 2014, pp. 145-149).

⁵Dividing the extra cash withdrawal of \$290 billion by the turnover ratio of 4.1 gives the needed rise in the stock of cash (\$71 billion).

called on to boost currency output far above their normal replacement rate. Although the demand for additional cash would be significant relative to the domestic stock of cash currently outstanding, the loss of \$71 billion in bank deposits would not have much effect on commercial banks' ability to fund asset portfolios. Total deposit balances are almost \$11 trillion so the deposit base would be reduced by only 0.6%.

From this it is clear that banks, if they raise fees significantly on depositor balances to recover the cost of negative interest rates, would also need to raise fees on depositor cash withdrawals as well. There are two incentives for banks to do this. First, if banks do not tax depositor cash use, their card revenues could fall significantly. Second, increased depositor cash use would lead to higher net cash withdrawals by banks at their central bank raising bank operating cost if these net withdrawals are themselves taxed.

2 Other Effects on Payments.

Other effects on payments depend on how deeply negative interest rates become and how permanent they are believed to be. As pointed out by McAndrews and Garbade (2012), the same incentives to delay (expedite) international payments when importers expect their currency to appreciate (depreciate) apply as well to domestic payments when interest rates are negative and payors face a fee on the size of their deposit balance. Here the incentive exists to pay invoices and trade credit early even without a discount for early payment. By the same token, incentives would exist to delay the collection of checks until a later time.⁶ As well, the demand for travelers checks and bank cashiers checks (made payable to the payor or a close relative) would also rise with their use delayed until a later date. Taxpayers could also make larger than necessary quarterly tax pre-payments and collect the excess later when taxes are due. It may also be possible to over-pay expected monthly credit card charges for the same reason. As well, workers would rather be paid weekly or bi-weekly rather than monthly since their average deposit balance—and the deposit fee—would be lower.

McAndrews and Garbade also suggest that some type of special-purpose institution could arise that holds a transaction account balance fully and only backed by deposited cash. This would be similar to a non-bank money market mutual fund that outsources its customer's transactions through a regular bank but holds no balance at the central bank and thus does not face a negative interest rate. Such an institution would likely specialize in holding only large cash balances but would be viable only if negative interest rates were large and if the cash deposited with it was not taxed in some manner.

⁶There is a time limit beyond which a check may not be paid due to a stale date. Sometimes this is written on the face of the check and can be 90 days from the date of issue.

3 Why Has Monetary Policy Moved to Negative Interest Rates?

The short answer is that just as raising interest rates can reduce the growth of aggregate demand and its associated effect on price inflation, lowering interest rates is expected to increase aggregate demand by lowering the cost of debt, induce new spending, and thereby reduce unemployment and the threat of deflation.

Table 1 illustrates what monetary policy is supposed to do. In row 1 if the nominal or observed interest rate $i_N = 1\%$ and inflation is currently 0% , the real or inflation adjusted interest rate would be $i_R = 1\%$. The real rate is not observed but derived from $i_N - \text{inflation}$. If the economy is in a serious recession and inflation becomes negative, the monetary policy response would be to lower the nominal rate to zero, the so-called lower bound of interest rate policy. But this need not change the real rate, which remains at $i_R = 1\%$, so there is no additional spending stimulus even though inflation is negative. Thus monetary authorities would like to lower the nominal rate into negative territory to stimulate the economy. If they lowered the nominal rate to a negative value, such as $i_N = -1\%$, then the real cost of existing floating rate debt and the real cost of new fixed rate debt (i_R) falls to zero and is expected to lead to new spending. An even stronger stimulus would be expected if the nominal rate would fall to -2% since then the real cost of new debt would be negative as well (at -1%).

Table 1: Illustration of Negative Interest Rates

	i_N	=	i_R	+	inflation
Current	1%	=	1%	+	0%
Response 1	0%	=	1%	+	-1%
Response 2	-1%	=	0%	+	-1%
Response 3	-2%	=	-1%	+	-1%

So how, exactly, is aggregate demand stimulated when interest rates are negative? Our experience with negative interest rates is too limited to answer this question at present but monetary authorities believe that a reduction of rates into negative territory will lead to results similar to when positive interest rates are lowered.

A large reduction in the positive value of nominal interest rates (say from 5% to 3%) can lead to a wave of fixed rate mortgage and other debt refinancing. What would have been debt repayment income for bond and mortgage-backed security holders is effectively shifted to borrowers who may spend a greater proportion of this income transfer or redistribution than would the original bond holders. Consumers and businesses that hold floating rate debt do not need to refinance to experience a lower cost of debt. This raises their disposable income so they can more easily pay down debt and also spend more than otherwise. Again, this represents a redistribution of income from lenders to borrowers.

As well, the lower cost of debt means that the cost of new business investment and consumer durable purchases (homes, autos, etc.) falls and typically leads to greater spending. Finally, lower interest rates, whether into negative territory or not, can lead to a capital outflow of "hot money" to other countries with higher returns. If large enough, the country's currency will depreciate and stimulate exports. Imports will fall

but the demand for domestic import substitutes will rise. After a lag, this will directly raise aggregate demand as well as import prices (limiting, to a degree, deflation).

There are two important qualifications here. First, monetary policy seems to be more effective at reducing the growth of aggregate demand and inflation than in stimulating growth that is already at a low level. In a recession, consumers worry about unemployment and put off durable goods purchases. Businesses with excess capacity put off new productive investment due to expected low growth in aggregate demand, making new investment unprofitable. Thus the main effect of lowering interest rates may be in the effect of redistributing income and/or a depreciation of the exchange rate as noted above.

A second qualification is that if loan rates follow market rates into negative territory, then actually making a loan not only requires the extension of principal to a borrower but also a payment to the borrower equal to the negative loan rate. This reduces the loan spread, a clear disincentive to make a loan even if demand has been stimulated. To offset a falling loan spread, banks could charge a negative interest rate on the value of deposits or implement/raise the monthly deposit account maintenance fee. Neither paying a borrower to take a loan nor charging depositors higher fees are especially happy events for banks. While domestic loan demand may be stimulated, domestic loan supply is not. Fortunately, if market rates become negative, the outflow of funds to other countries can depreciate the exchange rate (or limit its appreciation) and stimulate the domestic economy or maintain the parity of domestic currency with, say, the euro.

4 Ways to Mitigate the Incentive to Shift to Cash.

To reduce the incentive to withdraw cash, a way has to be found to limit the withdrawal of "extra" cash from bank balances at central banks and to do the same for consumers withdrawing "extra" cash from ATMs or over the counter. Businesses, overall, are net depositors of cash and so are less of a problem.

In a well-regarded paper, Goodfriend (2000) has suggested that each currency note could be embedded with a magnetic strip with a bar code. This would permit holders of cash—just like holders of deposit balances—to be identified and taxed. The tax could be assessed when cash is withdrawn from the central bank by banks and by depositors when withdrawing cash from their bank, or at some other juncture or time interval. Importantly, once the ownership of cash is recorded, the tax would still apply—even if it were hoarded (saved) and not used for transactions. If the cash was spent and transferred to another party, the tax could be collected from the new owner at some point. This would prevent the disproportionate use of cash by banks or depositors (both consumers and businesses).⁷

Taxing U.S. currency in the manner Goodfriend has suggested would take some effort to implement. It probably would not be popular due to the inconvenience of having to have your currency holdings "read" at some point to determine ownership

⁷Buiter (2009) has suggested a rather complicated procedure involving an exchange rate between cash and electronic money (which faces a negative interest rate) that is said to achieve the same end as Goodfriend's approach to taxing currency. As I am unable to present his suggestion in simple terms, it is only referenced here.

to pay the tax. Currency readers could be installed at the point-of-sale or at banks to periodically read the currency and deduct the tax from the owner's bank account at given intervals. Once in place, it would have the added benefit of identifying the cash holder as the owner of the currency being read making it more difficult for individuals to avoid paying taxes on cash income and/or engage in criminal activity due to the loss of anonymity.⁸

Instead of tagging cash so that a tax is paid, Rogoff (2014) and others have suggested doing away with cash altogether. Or notes above, say, \$20 could be redeemed to make cash hoarding difficult for very large amounts. This has some appeal. Alternatively, the government could issue a special card—like a pre-paid charge card or stored value card—that would replace cash. This would eliminate the need for government expenditures to redeem cash and also preserve the seigniorage benefit from issuing physical cash. If these stored value cards were replenished by debiting a bank account, it would eliminate the anonymity associated with cash and reduce tax evasion and criminal activity. While this approach is unlikely to be politically feasible at the present time, its benefits recommend it for future consideration. It has been unofficially studied in some countries.⁹

A similar arrangement has already been attempted in Europe. Banks issued reloadable stored value cards as a voluntary replacement for cash for terminal assisted point-of-sale transactions but the experiment did not seem to catch on with most consumers (Van Hove, 2006). Pilot tests in the U.S. had a similar fate. Consumers did not warm to the idea of having both cash and a reloadable card in the same wallet.

5 Taxing Cash as it is Withdrawn Using Existing Operating Procedures.

Instead of eliminating all or just the higher denomination currency notes or embedding currency with an identification number for taxation purposes, there is an operationally simpler way to impose negative interest rates on cash so that all payment instruments—cash as well as the non-cash instruments that require a bank deposit account—effectively bear approximately the same cost. Banks routinely deposit currency with their central bank, although procedures and fees are in place to limit the deposit of currency still fit for circulation. This serves to dispose of cash deposited at banks by retail businesses as well as check for counterfeit notes and remove unfit currency that can jam ATM machines. Later, banks may withdraw close to the same value of fit currency which they had previously deposited. The value of these deposits and withdrawals has fallen over time as the lifetime of low value notes has increased from 18 months in 1990 to close to 6 years today (Lambert, Ferrari, and Wajert, 2013).

⁸Both Bryant (2000) and Freedman (2000) offer additional comments on this approach. Although administrative difficulties abound, the procedure is technically feasible and has some precedent. Both John Maynard Keynes and Irving Fisher suggested that dated script (which was issued in small amounts) could assist in overcoming the "liquidity trap" of the Great Depression (Champ, 2008).

⁹Singapore has raised the possibility that a government could redeem currency and replace it with a government-issued card and account of equal value, effectively retaining seigniorage revenues as well saving tax revenues otherwise needed for currency redemption (Kok, 2002).

When a central bank imposes a negative interest rate on bank balances, the bank may do nothing and accept the higher cost if the negative rate is very small and thought to be reasonably temporary. If the negative rate is higher, perhaps around -1.0% or more, banks could transfer some or all of the balances that can be moved to purchase other domestic short-term liquid assets or even purchase foreign assets, if the central bank accommodates this action to lower reserves. As noted, if cash withdrawals are not taxed, banks may withdraw a disproportionate amount. Although there is a zero return, cash holds its value or even rises if prices are falling.

It would be a simple matter for the central bank (or its agent) to calculate quarterly (not daily or weekly) what a given bank's net cash withdrawal or deposit has been over this period and apply a quarterly charge equal to (or greater than) the negative interest rate to any net cash withdrawal.¹⁰ The net withdrawal calculation could be adjusted for the historical rate of normal currency growth in the country (around 2% or \$82 billion a year in the U.S.) so currency in circulation is not unduly restricted during the period when negative interest rates are in place.¹¹ Alternatively, if bank vault cash counts as satisfying reserve requirements, any net quarterly withdrawal of cash could raise reserve requirements by an equal amount and likely achieve the same end.¹²

The Goodfriend approach to taxing cash has the advantage of continuing to tax cash once it has been withdrawn, as occurs with deposit balances supporting the use of all non-cash payment instruments. This is not possible with the procedure outlined here. To discourage banks from hoarding cash it may be advisable to charge any bank's net cash withdrawal using a rate that is higher than the negative interest rate.¹³ How to limit the incentive for consumers to reduce their deposit balances by holding more cash for transactions or savings purposes, in response to higher bank fees on deposit balances, is more difficult.

U.S. banks typically do not have per-transaction fees for consumer use of payment instruments, except for wire transfers. As a result, consumers usually face a monthly account maintenance fee covering their payment transactions and other deposit operating expenses. As differences in consumer use of check, card, and ACH transactions among consumers are not large, an "average cost" is assessed rather than a fee per-transaction that would vary across individuals. Cross subsidization occurs here but is not excessive. The situation in Europe differs in that some countries' banks do impose per-transaction fees. Even so, European banks are more likely to charge a single fee on the depositor's balance or account to recoup their costs rather than differentially raise prices for different payment instruments, wire transfers excepted.

U.S. businesses, in contrast, typically face a separate fee for almost everything they do with a bank. They are generally charged a fee for each check, ACH, or wire transfer deposit to their account as well as each check, ACH, or wire they write or initiate.

¹⁰There is no need to pay banks a positive rate for a net cash deposit. The goal is to discourage the incentive to excessively withdraw cash, not to encourage its net deposit.

¹¹If this fee is considered grossly excessive, banks could attempt to exchange cash among themselves. This would work for a time but does not deal with the need to replace unfit currency notes nor allow for the normal growth of cash for transaction purposes.

¹²One has to be careful with changing reserve requirements since this affects the bank multiplier.

¹³Note that any tax on a net cash withdrawal is equivalent to a marginal exchange rate between electronic money—a debit to a bank's reserve account—and cash withdrawn from the reserve account. Either one affects the purchasing power of the cash being withdrawn.

They also face account maintenance fees for each account held across different demand deposit accounts, zero balance accounts, sweep accounts, etc. Businesses face per-transaction fees because their use of bank payment services varies considerably across firms in different industries as well as across firms within the same industry. Charging an average fee for all payment services together, as banks typically do for consumers, would involve considerable cross-subsidization among businesses.

Retail businesses commonly deposit and withdraw cash frequently from their bank. This is for overnight safekeeping. Small retailers typically pay at least a \$5 or more daily fee to do so. Larger retailers which handle much more cash use expensive armored courier services but are typically net depositors and, as such, would not be penalized for net cash withdrawals since they would not usually occur. Even so, banks would have past information on business cash deposits and withdrawals and could apply the same procedure used by a central bank to limit the incentive for banks themselves to withdraw their central bank balance in the form of cash. Very large firms already minimize their cash and deposit balance positions. Unneeded funds are shifted into short-term liquid assets and sold when working capital is needed.

U.S. consumers today know they have to pay a fee to withdraw cash from another bank's ATM and, in some cases, are assessed a fee if they withdraw cash from their own bank's ATM unless they arrange to have their biweekly/monthly paycheck directly deposited at their bank using an ACH direct deposit.¹⁴ Thus a bank would likely find it less disruptive for its consumer depositors to assess a direct fee on all ATM cash withdrawals rather than calculate a consumer's net cash withdrawal over some time period and assess a fee on that basis. The new ATM cash withdrawal fee could be set to balance, in some fashion, a fee the bank charges to hold the consumer's deposit balance.

What might be the fee paid on a consumer's deposit balance? The median U.S. family earns close to \$60,000 a year. If taxes were 20%, the family's after tax monthly deposit could be \$4,000, suggesting an average deposit balance of \$2,000. If the central bank's negative interest rate was -2% and was passed through to bank depositors, then $.02/12 \times \$2,000 = \3.33 would be the monthly fee on bank deposits (\$40 a year). This arrangement could apply to all consumer accounts or be implemented differentially for consumers with low, medium, or high average balances. Currently, the monthly account maintenance fee at the top 10 U.S. banks ranges from \$7 to \$15 and averages \$10 per month (generating \$120 a year in bank revenues per account). Being paid bi-weekly reduces this fee from \$3.33 to \$1.50 a month since the average consumer's deposit balance would be lower than if the depositor was paid monthly.

The fee would be even lower if banks were restricted to only recoup the expense they actually paid the central bank rather than merely apply the negative interest rate to all bank deposits without adjustment. That is, deposits at banks are typically much larger than bank balances with central banks so applying the central bank's negative interest rate on all deposits will over-recover bank costs.¹⁵

What might be the ATM fee for a cash withdrawal? The average value of an

¹⁴The reason is processing a deposited paycheck is more costly to a bank than accepting a direct deposit payroll transaction.

¹⁵For the U.S. this suggests that the fee paid by depositors would only be 25% of any negative interest rate charged by the central bank.

ATM cash withdrawal is \$118. If this withdrawal occurs weekly, the total monthly withdrawal would reduce deposits by \$531 a month. A 2% fee on this withdrawal would be \$0.90 a month. But, as noted above, if the negative interest rate is -2%, banks would need only to charge a portion of this central bank fee to recover their costs from depositors.

Importantly, banks don't have to charge a fee on the value of a depositor's balance to recoup their cost of negative interest rates paid to central banks. Instead they have the option of paying zero interest on a depositor's balance and assessing a fixed fee on a depositor's account. That still leaves the problem of determining what this fee would be to recoup their central bank cost but it also means that there would be no incentive for either consumers or businesses to withdraw extra cash from their deposit balance.

Regardless of the deposit balance, withdrawing more cash for transaction or hoarding purposes will not save any money if the fee is on the account rather than the balance in the account. The fee is the same if more or less cash is withdrawn. U.S. depositors already pay \$7 to \$15 per month per account, totaling some \$120 a year. Such an arrangement is far simpler than charging a fixed fee on a depositor's balance and would eliminate much of the backlash from depositors who, while used to paying a fixed monthly fee on their bank account, are definitely not used to paying a fee on the size of their deposit balance.¹⁶

If a bank was so incautious as to apply fixed fee on the value of a depositor's balance, as does the central bank on a bank's balance, then they would also have an incentive to charge a fee on the net cash withdrawal by businesses and cash withdrawals from ATMs by consumers. This is because if they do not do this, their card revenues could fall significantly and they would incur a fee for their net withdrawal of cash from their central bank balance needed to meet the extra cash being withdrawn from their ATMs.

6 Conclusion.

Banks commonly hold balances with their central banks for reserve requirements or to clear and settle interbank payment transactions. Balances may also be held for safekeeping at the central bank in uncertain times when bank purchases of other assets are not desired. In reducing the zero or positive interest rate paid on these balances to a negative value, the central bank seeks to induce banks to move their funds into productive investments in the economy to offset a falling or low aggregate demand and stabilize or expand employment. Negative rates can also be used to induce banks and their depositors to shift funds to other countries which offer higher returns, a movement which may depreciate the exchange rate and stimulate the country's export sector or maintain parity with a major trading partner.

Banks can also reduce their central bank balance by withdrawing cash or purchasing other domestic assets. Once cash is withdrawn, it will only face a zero rate of return and thus retain its purchasing power. The incentive for banks to withdraw cash from

¹⁶When U.S. debit card interchange fees were reduced by almost 50% as a result of the Durbin amendment to the Dodd-Frank financial legislation and large banks tried to recoup this lost revenue stream by applying a \$5 monthly fee to use a debit card, they were forced to abandon the effort due to the resulting consumer uproar.

their central bank balance can be addressed by the central bank charging the negative interest rate on a bank's quarterly net cash withdrawal. A similar procedure can be applied to businesses to limit their incentive to withdraw cash. For consumers that face a fee on the size of their deposit balance, a fee can be applied on the average value of an ATM cash withdrawal. Finally, the incentive for consumers or businesses to withdraw extra cash is eliminated if banks impose a fixed fee on depositors' accounts, rather than a fee on the size of their balance. Other methods of taxing cash held by banks and their depositors exist but can be administratively difficult to implement and, realistically, are not at present politically feasible.

7 Bibliography.

Board of Governors of the Federal Reserve System (2015), *Financial Accounts of the United States*, Federal Reserve Statistical Release Z.1, Checkable Deposits and Currency.

Bryant, R. (2000), "Comment on Overcoming the Zero Bound on Interest Rate Policy", *Journal of Money, Credit and Banking*, Vol. 32, No. 4, Part 2, November: 1036-1050.

Buiter, W. (2009), "Negative Nominal Interest Rates: Three Ways to Overcome the Zero Lower Bound", NBER Working Paper Series, June, <<http://www.nber.org/papers/w15118>>.

Champ, B. (2008), "Stamp Scrip: Money People Paid to Use", Federal Reserve Bank of Cleveland *Economic Commentary*, April, <http://findarticles.com/p/articles/mi_qa5294/>.

Federal Reserve System (2014), *The 2013 Federal Reserve Payments Study*, (Detailed Report) July.

Freedman, C. (2000), "Comment on Overcoming the Zero Bound on Interest Rate Policy", *Journal of Money, Credit and Banking*, Vol. 32, No. 4, Part 2, November:1051-1057.

Goodfriend, M. (2000), "Overcoming the Zero Bound on Interest Rate Policy", *Journal of Money, Credit and Banking*, Vol. 32, No. 4, Part 2, November:1007-1035.

Kok, L., 2002. "Singapore Electronic Legal Tender (SELT)—A proposed Concept", in: *The Future of Money*, Organization for Economic Co-Operation and Development, Paris, pp. 147–161.

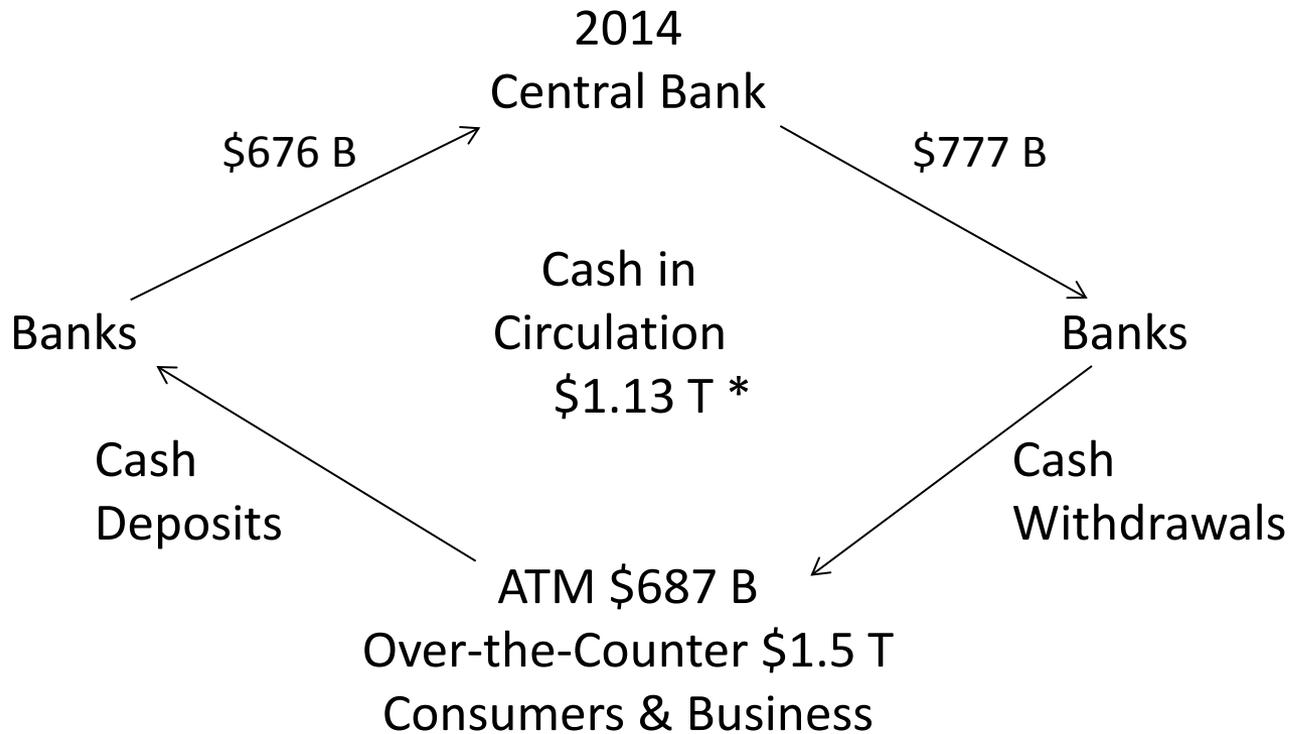
Lambert, M., S. Ferrari and B. Wajert (2013), "Costs and Benefits of Replacing the \$1 Federal Reserve Note with a \$1 U.S. Coin", Staff Working Paper, Federal Reserve Board, December.

McAndrews, J., and K. Garbade (2012), "If Interest Rates Go Negative . . . Or, Be Careful What You Wish For", *Liberty Street Economics*, August 29, at: <<http://libertystreeteconomics.newyorkfed.org/2012/08/if-interest-rates-go-negative-or-be-careful-what-you-wish-for.html>>.

Rogoff, K. (2014), "Cost and Benefits of Phasing Out Paper Currency", NBER Working Paper Series, <<http://www.nber.org/papers/w20126>>.

Van Hove, L. (2006). 'Why Electronic Purses Should be Promoted', *Banking and Information Technology* (Universität Regensburg, Germany), Nr. 2, June: 20-31.

Figure 1: The U.S. Stock/Flow Cash Circle



* Domestic stock of cash is \$636 B (B = billion, T = trillion).