

# Estimating Canada's Effective Lower Bound

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- Savers have an incentive to switch from deposits to cash when nominal interest rates fall sufficiently below zero.
- The costs of storing and insuring cash dictate the effective lower bound in Canada, which is likely to be around -50 basis points.
- The pass-through of monetary policy changes to consumer and business borrowing rates may be only partial when rates are low or negative.
- The Bank's framework for the implementation of monetary policy can accommodate negative rates.

It has long been accepted that, in practical terms, nominal interest rates cannot fall below zero because investors can always earn a zero nominal return simply by holding cash. This concept has been termed the “zero lower bound” on nominal interest rates. Theoretically, the existence of this zero lower bound limits a central bank's ability to provide further stimulus to the economy through conventional decreases in policy rates below zero.

However, this conventional wisdom about the constraints imposed by the zero lower bound has been contradicted by recent international experience: interest rates have become negative in Sweden, Denmark, Switzerland, the euro area and Japan, suggesting that the effective lower bound (ELB) on central bank policy rates could be below zero, at least in those countries.

In 2009, the Bank of Canada determined that the ELB on its key policy interest rate was 25 basis points (bps). At the time, the Bank was concerned about the potential disruption that low rates might cause in some key funding markets. In December 2015, the Bank released an updated version of its *Framework for Conducting Monetary Policy at Low Interest Rates*, which includes the potential use of negative policy rates in Canada as part of the Bank's unconventional policy tool kit, and estimated Canada's ELB to be around -50 bps (Poloz 2015).

This article outlines the analysis that underpins the Bank's current estimate of the ELB, examines the economics and practicalities of negative interest rates, and touches on theoretical considerations that could influence further thinking on the ELB.

## The Costs of Holding and Using Cash

The existence of cash serves as the main constraint on nominal interest rates falling below zero. If holding cash entailed no costs, interest rates on savings and investments could never go below zero because savers and

investors would simply switch to holding zero-yielding cash. But holding cash—especially in large quantities—does have costs. These costs, which are primarily for storage and insurance, mean that the effective return on holding cash is actually negative. How negative depends on the level of those associated costs as well as the inconvenience cost of using cash for large-value payments. In theory, the ELB can be reduced—or even eliminated—by altering the zero-yielding nature of cash (Box 1).

◀ *The negative return on holding cash is effectively negative after costs for storage and insurance are taken into account*

We estimate the costs of holding cash using three sources:

- (i) industry estimates for wholesale cash storage;
- (ii) a comparison between wholesale cash storage costs and those for storing precious metals; and
- (iii) costs associated with precious-metal-backed exchange-traded funds (ETFs), which are liquid financial instruments for investing in vault gold and silver.

Wholesale cash storage estimates suggest that the cost of holding cash (i.e., storage and handling) is fairly low. When insurance requirements are taken into account, cash storage costs for the \$100 denomination, for example, can be up to 35 bps per year.<sup>1</sup> Dormant storage costs, excluding insurance, for cash that is stored and not handled or transported frequently could be less than 5 bps for the \$5 denomination and less than 1 bp for

<sup>1</sup> All the estimates of storage costs reported in this section are denoted in basis points per year to conform with the method of reporting policy interest rates. For example, a cost of 35 bps suggests it costs \$3.50 to store \$1,000 for one year.

## Box 1

### Further Reducing or Eliminating the Effective Lower Bound: Theoretical Considerations

The presence of an effective lower bound (ELB) is driven by the existence of an alternative: zero-yielding cash. In theory, the ELB can be reduced—or even eliminated—by increasing the cost of using and holding cash or by eliminating cash altogether. Adopting either of these alternative futures would be a significant change from the current practice. Such a change is not completely beyond the realm of possibility, however: a significant change in the monetary policy regime already occurred some time ago in the move away from the gold standard after the Great Depression (Agarwal and Kimball 2015).

The first group of ideas put forward to further reduce the ELB involves increasing the cost of holding cash. The earliest such proposal was by Gesell (1906), who suggested a stamp tax on money: to use a note as legal tender, holders of cash would be required to pay for the note to be stamped periodically. In a more recent proposal, holding cash could be made more expensive by introducing a time-varying exchange rate between cash and electronic money (Agarwal and Kimball 2015). To discourage holding cash, the exchange rate would need to be set at a level where the expected return from investing at the policy rate is greater than the expected return from holding cash.

A second group advocates for eliminating cash altogether (Buiter 2009; Rogoff 2015; Haldane 2015). The monetary policy transmission should continue to be effective, even if electronic payments replaced cash in all transactions (Woodford 2003). However, although the volume of cash in retail transactions is decreasing as a result of payment innovations, such as contactless credit cards (Fung, Huynh and Stuber 2015), the value of cash in retail transactions remains stable and the amount of currency in circulation in Canada continues to grow in line with GDP growth. It therefore seems unlikely that cash will naturally be replaced completely by electronic payments in the foreseeable future.

While these proposals are all theoretically feasible, they do present several practical challenges. First, reducing or eliminating the use of cash could create incentives for Canadians to use other currencies in their economic transactions. A widespread adoption of other currencies would undermine the effectiveness of negative interest rates as a tool for monetary policy. Second, some Canadians, such as those with low incomes and the elderly, have a stronger preference for cash (Fung, Huynh and Stuber 2015) and may be disproportionately affected by any proposals that eliminate or discourage its use.

the \$100 denomination. As such, wholesale storage pricing is mainly driven by insurance requirements, not by the required physical space for storage. Contrary to a commonly held belief, this implies that denomination does not play an important role in overall cash storage costs. This notion is further confirmed when investigating the cost of storing precious metals.

A reasonable estimate of the cost of storing cash can be obtained from a comparison with storage costs for precious metals such as gold and silver, which must also be stored in vaults and insured.<sup>2</sup> Despite a wide range of physical space requirements associated with storing different precious metals, overall costs are of similar magnitude to those for cash because insurance is a larger part of the cost. Publicly available estimates for storage costs, including insurance, range from 40 to 50 bps for silver and from 20 to 35 bps for gold, even though silver requires more than 100 times the storage space than the same value of gold.

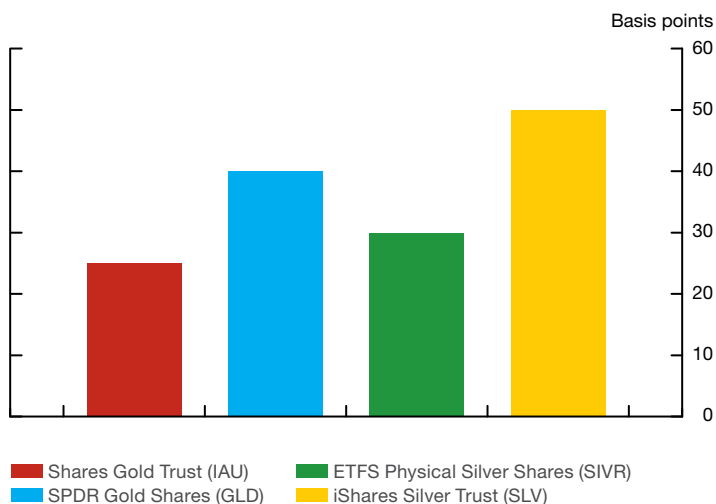
Precious-metal-backed ETFs charge a fee that reflects the cost of storing and insuring the underlying precious metal as well as fund-management fees and expenses. We estimate that the pure storage and insurance costs of gold and silver likely range from 20 to 45 bps after fund-management fees and expenses are deducted (Chart 1). This is broadly consistent with the cost of storing gold and silver with companies that provide vaults.<sup>3</sup> Taken together, these estimates suggest that the cost of holding cash, including storage and insurance, is most likely between 25 and 50 bps, given that the space required to store a given value of cash in the \$100 denomination sits between that for the same value of gold and silver.

Holding cash not only entails storage and insurance costs but also forgoes the convenience benefits of being able to make payments electronically. For commercial entities that frequently transfer large payments (e.g., payroll obligations), there would be a strong convenience benefit to using electronic payment methods associated with bank deposits. Based on industry

◀ Overall costs of a storing precious metals are of a similar magnitude to those for cash regardless of space requirements because insurance is a larger part of the cost

**Chart 1: Gold and silver storage costs**

Fees of exchange-traded funds



Source: etfdb.com

Last observation: 28 January 2016

<sup>2</sup> Unlike cash, precious metals may have different properties (weight, flammability) that could affect theft and fire insurance premiums. We assume that these differences have a minimal impact on insurance and storage costs.

<sup>3</sup> We assume that the fund-management fees and expenses are a small portion of the total fees, given that several equity ETFs have all-in ETF fees of between 5 and 10 bps.

estimates, cash transportation costs can be up to or even more than 1 bp per shipment, depending on the distance travelled and the value of the shipment. Although small, such a cost would become material if there was a need to settle large-value transactions frequently—even as seldom as twice a month for payroll settlements could add up to almost 25 bps per year. Thus, corporate customers may be willing to accept a small negative return on their deposits rather than switch to cash. For them, the convenience value could be large. Based on these considerations, we think a conservative estimate for the convenience value could be between 0 and 25 bps.<sup>4</sup>

Combining both the costs of holding and using cash, we estimate that the ELB in Canada is likely between -25 bps and -75 bps, with a midpoint estimate of -50 bps.

Of course, there is uncertainty around any point estimate. Some factors can push the ELB toward the low (more negative) end of our estimates, or further. First, our estimate of the ELB is for the target for the overnight rate (the Bank's policy rate). As such, it ignores the wedge between the overnight rate and prevailing commercial interest rates. Participants in the economy face interest rates that are generally higher than the overnight rate, and their decision to hold cash will be based on those interest rates, not on the overnight rate, which could therefore go below that suggested by the costs of holding and using cash without triggering an abnormal increase in the demand for cash. Second, the insurance costs of storing cash would likely increase in the event of a surge in the demand for such storage, reducing the lower bound further. Current industry practice suggests that there is a finite amount of cash that any individual insurance company is willing to insure. Third, there is uncertainty around our estimates, and the convenience value of making payments electronically could simply be higher than estimated.

In contrast, other factors could bring the ELB closer to the high (less negative) end of our estimates. For example, the decision to hold cash in significant amounts likely depends on both the level of interest rates and on how long the rates are expected to remain negative. If negative rates were to endure, financial innovations could develop over time to reduce the storage and usage costs associated with cash (Garbade and McAndrews 2012). An ETF physically backed by cash stored in a vault, for example, could help its investors achieve economies of scale, as such funds currently do for precious metals, yielding higher returns for investors than debt instruments with negative yields. A special-purpose bank that has only cash as an asset could also provide traditional banking services, such as chequing accounts and the ability to make electronic payments. Gold-backed payment cards have even been developed, allowing customers to make retail payments using gold stored in a vault.<sup>5</sup> Such financial innovations may make the ELB less negative by reducing costs of storing and using cash. All of this suggests that the lower bound becomes less negative as the expected duration of negative rates increases.

◀ *Financial innovations may make the effective lower bound less negative by reducing costs of storing and using cash*

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<sup>4</sup> The fee charged on credit cards (1 to 3 per cent) has sometimes been used as a proxy for this convenience value. This figure may be an overestimate, given that the fee is charged on the value of the transaction, not on the total cash balance.

<sup>5</sup> For more details, see [www.bitgold.com](http://www.bitgold.com).

## Financial Market Frictions Associated with Negative Rates

Market frictions exist in many financial contracts and products with pay-offs that are explicitly or implicitly constrained from going below zero, including money market mutual funds (MMMFs), floating rate notes (FRNs) and repurchase agreements (or repos). Financial markets in European countries with negative interest rates continue to function reasonably well, suggesting that these market frictions have not posed any significant constraints on negative rates. Generally, affected market participants in Europe have used two methods to adapt to negative interest rates. Some have accepted a reduced profit margin or used other business lines to subsidize lower revenue or losses, while others have altered financial contracts by removing any implicit floor when interest rates became negative. This experience suggests that Canadian financial markets could also adapt to negative rates, although the relative importance of some of these markets differs for Canada and Europe. We discuss the potential effects of negative rates in Canada on each of the financial products noted above.

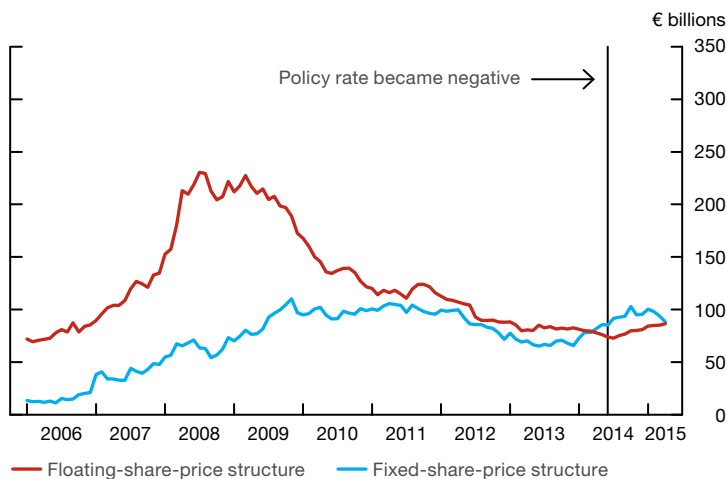
◀ *The European experience with negative rates suggests that Canadian financial markets could also adapt to negative rates*

### Money market mutual funds

MMMFs have a fixed share price and pay their shareholders a non-negative dividend that is roughly equal to a prevailing money market interest rate less management fees. Should money market interest rates become negative, MMMFs with a fixed share price would become unprofitable. Indeed, the immediate response of many euro-denominated MMMFs to negative rates was to waive their expense fees and absorb the losses rather than passing them on to their investors. Some euro-denominated MMMFs have prepared for a more persistent negative rate environment by converting from a structure with a fixed share price to one with a floating share price.<sup>6</sup> Overall, however, evidence in Europe indicates that negative rates have generally had minor effects on MMMFs, which have not experienced abnormal redemptions during the current episode (Chart 2).<sup>7</sup> While similar behaviour could

**Chart 2: Euro-denominated money market mutual fund assets**

Assets under management of MMMFs domiciled in Luxembourg and Ireland



Source: Morningstar

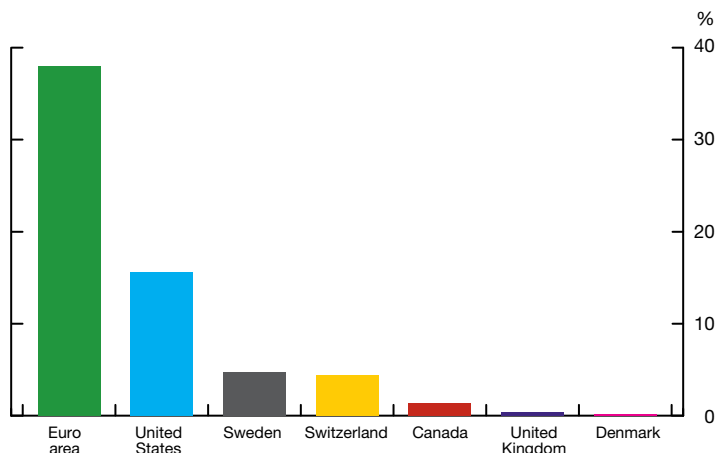
Last observation: April 2015

<sup>6</sup> See <http://www.bloomberg.com/news/articles/2012-10-19/jpmorgan-readies-clients-for-negative-euro-money-yields>.

<sup>7</sup> When negative rates were introduced in Japan, some Japanese fund managers announced that they would close their money market funds.

**Chart 3: Market size of money market mutual funds by region**

Money market fund assets as a share of GDP



Sources: Investment Company Institute (ICI) and Central Intelligence Agency (CIA) World Factbook

Last observation: 31 December 2014

be expected in Canada, MMMFs are a relatively small part of the financial system, and the impact of any potential disruption in this sector on the functioning of the financial system as a whole would therefore be limited (**Chart 3**).

## Floating rate notes

Issuers of FRNs pay coupons to their bondholders based on a short-term, floating rate.<sup>8</sup> Several FRNs have explicit clauses preventing interest rate payments from falling below zero. For those that do not have such a clause, investors have perceived an implicit floor of zero.<sup>9</sup> Thus, in principle, FRN issuers are constrained from accessing funding at negative rates. In European FRN markets, coupon rates have not fallen below zero, even though the 3-month Euro Interbank Offered Rate (EURIBOR) has been negative since April 2015. Issuers of FRNs have also adapted, however, issuing FRNs at a price above par, which in turn implies a wider coupon spread to EURIBOR to reduce the possibility that actual coupon payments approach negative territory. It is not inconceivable that Canadian FRN issuers may also respond to negative rates in a similar way.

## Repos

When rates become negative, the securities borrower in a repo transaction incurs a smaller penalty for failing to return the borrowed security, potentially resulting in more frequent failures to deliver securities in repo transactions. Conceptually, this could lead to disruptions in the overnight repo market, which could impair the Bank's ability to guide the overnight rate toward its target.<sup>10</sup> In Europe, the general collateral (GC) repo market has continued to function normally despite repo rates being very close to zero from

<sup>8</sup> FRNs are securities with a coupon payment based on a short-term benchmark interest rate, such as the Euro Interbank Offered Rate (EURIBOR) in Europe or the Canadian Dollar Offered Rate (CDOR) in Canada. FRNs outstanding in Canada represent about \$170 billion, or about 10 per cent, of total non-Government of Canada bonds outstanding.

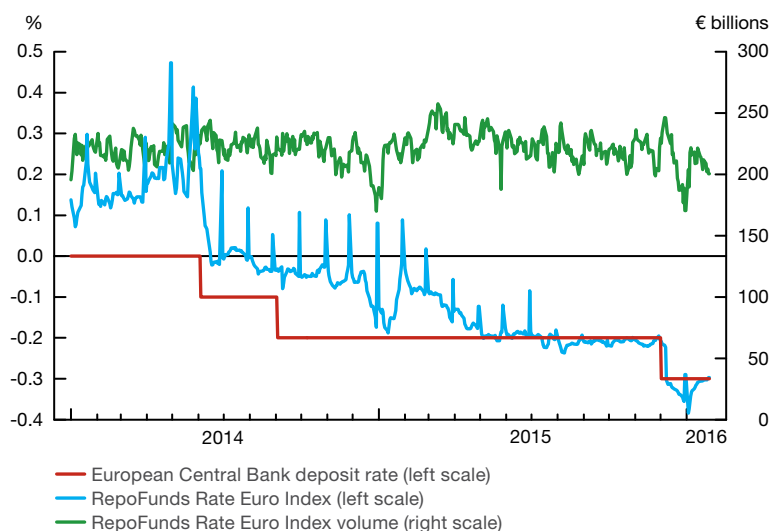
<sup>9</sup> For example, European investors are now seeking contractual guarantees that they are not liable to borrowers when floating rates become negative. "Box 1: The Financial System Implications of Negative Interest Rates," Bank of Canada *Financial System Review* (June 2015): 7.

<sup>10</sup> General collateral (GC) repo markets are important for the implementation of monetary policy in Canada, since, unlike other jurisdictions, our target is the overnight (i.e., 1-day) GC repo rate of interest.

2012 to 2014 and persistently negative since 2014. Repo volumes have been steady over this period (Chart 4), and there is no evidence of market disruption or increased fail rates.<sup>11</sup> The lack of settlement failures in Europe could also indicate non-negligible reputational costs associated with settlement failures.

While negative rates could lead to more settlement failures in the repo market, this problem is not insurmountable. After US rates were reduced to their ELB during the financial crisis, for example, chronic settlement failures of US Treasury transactions led the US Treasury Market Practices Group (2009) to adopt an industry-wide fail fee, which reduced settlement failures in the repo market substantially.

**Chart 4: Trading volumes in the euro area core funding markets**



Source: Bloomberg

Last observation: 29 January 2016

## The Economics of Implementing Negative Rates

The Bank of Canada operates a corridor system with no reserve requirements. Its target for the overnight rate is at the midpoint of a 50-basis-point corridor. Participants in the Large Value Transfer System are charged the rate at the upper limit of the corridor (the Bank Rate) for overdraft loans from the Bank. Participants with end-of-day excess balances with the Bank are compensated at the rate at the lower limit of the corridor (the deposit rate).<sup>12</sup> Participants thus have economic incentives to trade within the operating band and close to the target rate. Since it is a closed system, participants with a short cash position know that there is at least one other participant with a long (extra) cash position.

The incentives to trade near the target rate remain the same when the target policy rate is zero or negative: participants are better off trading with each other at interest rates inside the operating band than with the Bank at the limits of the operating band. If the target rate were -25 bps, for example, participants' long money at the end of the day would receive a

◀ *Incentives to trade near target remain the same whether the target policy rate is zero or negative*

<sup>11</sup> "Box 1: The Financial System Implications of Negative Interest Rates," Bank of Canada *Financial System Review* (June 2015): 7.

<sup>12</sup> For more details, see <http://www.bankofcanada.ca/markets/market-operations-liquidity-provision/framework-market-operations-liquidity-provision>.

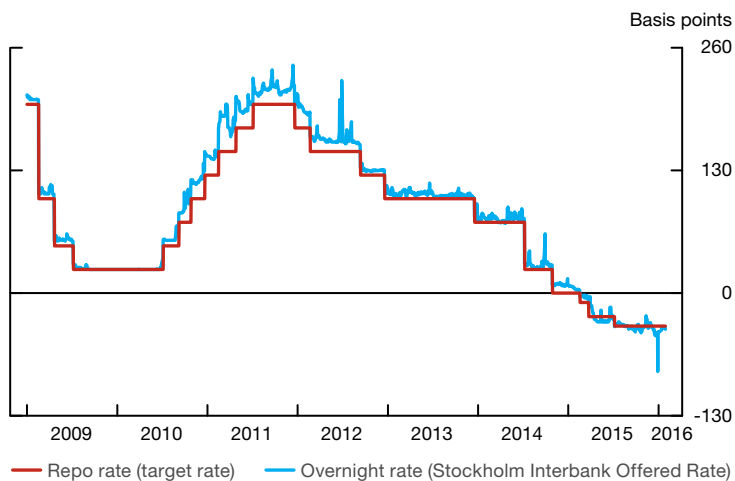


lower-than-market rate of -50 bps on such balances deposited at the Bank. Similarly, participants that are short money at the end of the day would pay a higher-than-market rate of 0 bps on overdraft loans from the Bank. Participants would therefore be better off trading with each other within the band and would generally negotiate a rate near the target rate of -25 bps. The Bank's operating framework should therefore continue to function effectively with the target rate below zero.

Some jurisdictions with large reserve surpluses have tailored their monetary policy framework to the negative interest rate environment. Switzerland and Japan, for example, have exempted a significant portion of banks' deposits at the central bank from being subject to negative rates. Such a system of tiered negative rates serves to limit the impact of negative interest rates on banks' profit margins. In Canada, however, banks do not have significant deposits with the Bank of Canada; hence, a negative deposit rate does not have the same adverse effect on the profit margins of Canadian banks.

When rates are below zero, the Bank is able to maintain the overnight rate near the target rate, provided that markets are functioning well and participants are not hoarding cash, which is likely to be the case if the target is at or above the Bank's estimated ELB. Indeed, in European jurisdictions, monetary policy has continued to function well even with overnight rates below our, perhaps conservative, estimated ELB of -50 bps. In Sweden and Switzerland, market interest rates continue to trade near the target rate for these jurisdictions, even though the rates are set below -50 bps (Chart 5 and Chart 6).

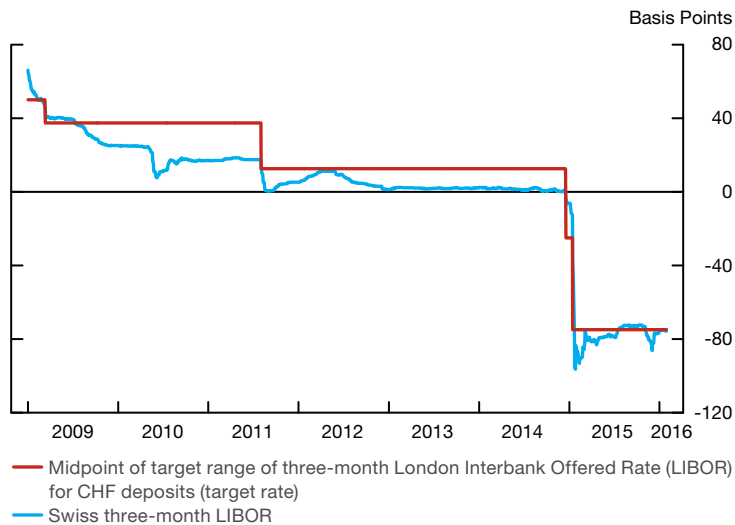
**Chart 5: Swedish overnight rates relative to target**



Sources: Sveriges Riksbank, Datastream and Bloomberg

Last observation: 29 January 2016



**Chart 6: Swiss three-month rates relative to target**

Sources: Swiss National Bank, Datastream and Bloomberg

Last observation: 29 January 2016

## Monetary Policy Transmission at Low or Negative Rates

In theory, negative interest rates do not fundamentally alter the monetary policy transmission mechanism. They are expected to stimulate the economy by affecting market interest rates, bank lending, asset prices and exchange rates.<sup>13</sup> Empirical observations, however, suggest that the monetary policy transmission mechanism may have become weaker at low or negative rates.

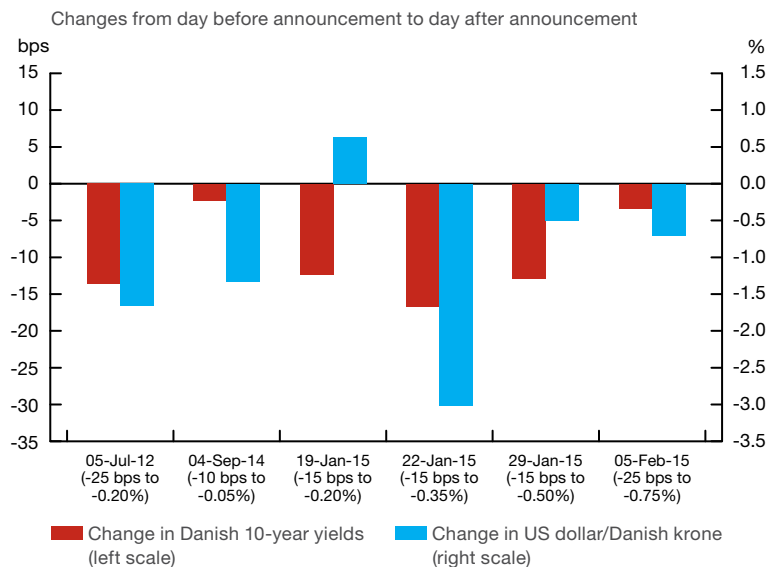
Transmission of changes to monetary policy through the bank lending channel may be less effective when rates become negative. In the euro area, the pass-through of policy rate cuts to retail deposit rates has been shown to be weaker when rates are already low but still positive (Paries et al. 2014). A similar pattern is observed when rates are negative. In Switzerland, Denmark and Sweden, retail deposit rates for commercial banks have not declined to the same extent as central bank target rates and remain in positive territory. Swiss and Danish banks, however, have largely passed on the negative rate cuts to their large corporate deposit accounts. A recent survey suggests that many depositors are likely to withdraw their deposits from banks and/or change their saving behaviours when faced with negative rates.<sup>14</sup>

The transmission of further policy rate cuts in the negative zone through bank lending rates has been diminishing. Banks are reluctant to pass on negative rates to their retail depositors, which limits the extent to which banks can reduce their lending rates without sacrificing profitability (Jensen and Spange 2015). In fact, some critics relate the recent weak performance of some European banks to concerns over a decline in their profitability, which is seen to be associated with negative rates. Some even argue that if the negative effect on bank profitability persists, it may lead to a tightening of financial conditions, reducing the effect of monetary stimulus. Swiss banks, for example, increased their mortgage lending rates following the introduction of negative interest rates (Bech and Malkhozov 2016).

<sup>13</sup> Buiter and Panigirtzoglou (2003) provide an early analysis of this rationale in a New Keynesian model.

<sup>14</sup> In a survey of 13,000 consumers commissioned by ING, about three-quarters of the respondents said they would withdraw funds from their savings accounts, and 10 per cent responded that they would save more if rates were negative (Cliffe 2016).

**Chart 7: Danish yield and currency reactions to rate cuts below the zero lower bound**



Sources: Bloomberg and Datastream

There is evidence, however, that negative rates are being transmitted to long-term benchmark yields, as expected. It is well understood that monetary policy does not have total control over long-term rates but can affect long-term yields through changing expectations for future short-term rates. This is consistent with the recent experiences of Denmark and Sweden. Denmark, a small, open economy like Canada, is a good example of how negative rates transmit to longer-term yields. The Danish central bank has reduced the overnight policy rate deeper into negative territory on six occasions. For each policy rate announcement, we found that Danish 10-year yields dropped by as much as 15 bps (Chart 7).<sup>15</sup> Swedish announcements of negative rates have had a similar effect on 10-year yields (Chart 8).<sup>16</sup> The magnitude of the effects is broadly consistent with that of a rate cut when rates are positive.

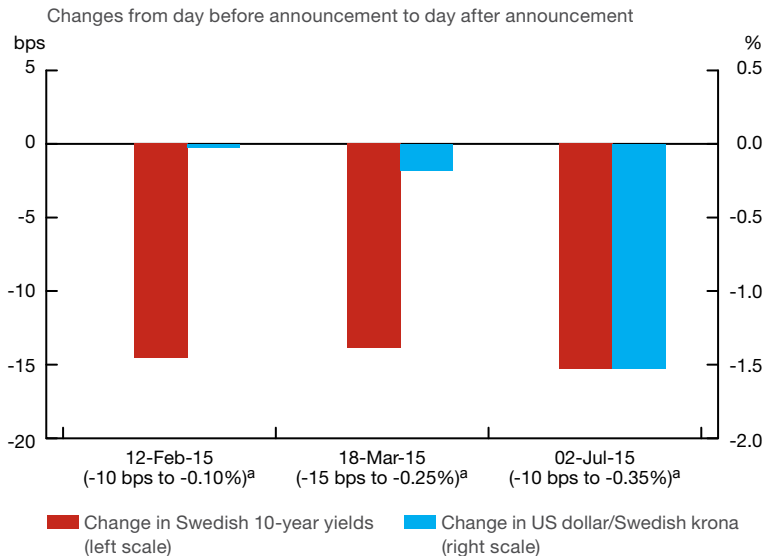
Moreover, there are indications that the transmission of monetary policy through the exchange rate channel continues to function when rates are negative. Exchange rates seem to have responded to a reduction in interest rates in Europe. Both Sweden and Denmark introduced negative rates in response to capital inflows and appreciation pressures. Our empirical analysis suggests that Swedish and Danish exchange rates have depreciated following most of their negative rate announcements. The Swedish krona depreciated with every announcement of a rate cut. The Danish krone depreciated on five out of six dates when rate cuts were announced, with the largest depreciation (3 per cent) in January 2015 (Chart 7 and Chart 8). In the euro area, since the ECB deposit rate became negative in July 2014, the euro/US\$ exchange rate had depreciated by almost 20 per cent by the end of 2015; this depreciation may also be attributable to the ECB's quantitative easing program and the divergence of its monetary policy from policy in the United States, among other factors.

◀ As expected, negative rates are being transmitted to long-term benchmark yields

<sup>15</sup> The effect of the 29 January 2015 announcement shown in Chart 7 may be due to a combination of the negative rate announcement and the announcement by the Danish Ministry of Finance on 30 January 2015 that it would suspend the issuance of government bonds to offset an appreciation of the krone.

<sup>16</sup> Since the Swedish announcements also included changes to its quantitative easing program, it is difficult to clearly separate the effect of quantitative easing from that of negative rates.

**Chart 8: Swedish yield and currency reactions to rate cuts below the zero lower bound**



a. Quantitative easing was announced simultaneously with a cut to the policy rate.

Sources: Bloomberg and Datastream

## Conclusion

We do not know with certainty where the ELB for the Bank of Canada policy rate is, nor do we know precisely how long it could stay negative without causing disruptions to the financial system or a surge in the demand for cash. We do know that the ELB in Canada is lower than the earlier estimate of 25 basis points. Based on our analysis of international experience as well as the costs of holding and using cash, and taking into account Canadian market circumstances, our current best estimate is between -25 bps and -75 bps, with a median estimate of -50 bps. The experience in Europe demonstrates that markets have adapted reasonably well to the challenges associated with negative interest rates. Given uncertainty over the precise level of the lower bound, the Bank will continue to monitor both market functioning and the demand for cash in other countries to identify signals that their policy rates are approaching their lower bound. This will continue to inform Bank estimates of the potential ELB in Canada, should negative rates ever be deemed appropriate.

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