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Cash for Transactions or Store-of-Value?

A comparative study on Sweden and peer countries[*]

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Abstract:
We estimate the demand for transaction and non-transaction cash balances in Canada, Denmark, Iceland, Sweden and Norway over the last decades using the seasonal method. These countries share many features that are relevant for cash demand, but nevertheless show large differences in terms of aggregate cash balances. While Canada, Iceland and Denmark have seen increased aggregate cash balances, Norway and especially Sweden have seen a dramatic decline. We find that transaction balances have decreased somewhat in all of the countries and the differences in aggregated cash balances is due to differences in the development of non-transactional cash balances. We argue that different de facto legal tender status, crisis exposures, foreign demand and cash supply-side policies help explain these findings.

JEL codes: E41, E51, E58

Key words: cash, banknotes, seasonal method, transactions, hoarding

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1. Introduction

Sweden has seen a dramatic and unprecedented fall in the demand for cash (banknotes and coins). Since its peak in 2007, the nominal value of Swedish krona (SEK) currency in circulation has fallen by almost 50 %. At the same time, most other OECD countries experienced a 'cash paradox' whereby the demand for cash increased, despite the general trend towards lower use of cash for transactions.[1]

It seems that Sweden's divergent development cannot be explained by empirical cash demand models. Armelius et al. (2022), for instance, estimate cash demand functions that perform well for OECD countries, but not for Sweden. They conclude that a unique Swedish combination of events and policy measures have led to the dramatic decline of cash demand in Sweden. Engert et al. (2019) make similar arguments.

In this paper, we take a different approach and ask if we can explain the divergent Swedish development with differences between Sweden and other countries in the use of cash for transactional and non-transactional purposes. This approach is inspired by other papers that relate the cash paradox to "hoarding" of banknotes for store-of-value purposes. These papers find support for this view in the fact that the share of large denomination banknotes in total currency in circulation (CiC) has increased in many countries after the great financial crisis in 2008, see e.g. Ashworth & Goodhart (2020), Jobst & Stix (2017), Rösl & Seitz (2022a), Shirai & Sugandi (2019).

We include four reference countries in our study, namely Norway, Denmark, Iceland and Canada. They share key similarities with Sweden as they are small open high-income economies with a mature payment market and a banked and financially literate population. Two of the countries, Norway and Denmark, are neighbouring Nordic countries and very similar to Sweden. Despite the similarities, CiC developments differ significantly between these countries.

In order to estimate the transactional and non-transactional cash shares, we apply the so-called seasonal method. This method rests on the presumption that the seasonality in cash balances (or banknotes) held for transactions is different from that used for other motives, especially that it has a higher seasonal amplitude. A key merit of the method is that it does not depend on the arguable assumption that small denomination notes are only used for transactions and that large

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[1] Gresvik & Kaloudis (2001) were the first to introduce this term into the literature.

denomination notes are only used for store of value purposes. Furthermore, it does not rely on the availability of time series on denominations and more or less arbitrary distinctions between small and large denominations. The method was first developed by Sumner (1990) and has later been used in many studies, see, e.g., Assenmacher et al. (2019, ch. 4), Bartzsch et al. (2013), Finlay et al. (2019), Porter & Judson (1996), Lalouette et al. (2021), Seitz et al. (2022).

Somewhat contrary to expectations – given the trend towards digital payments – we find that falling CiC in Sweden (and Norway) is predominantly due to a decline in non-transactional cash balances, and not a decline in cash held for transactional motives. More in line with expectations is the result that the cash paradox in Canada and Iceland and the more stable cash developments in Denmark are due to increased demand for cash held for non-transactional purposes. Finally, and not surprisingly, we find that transactional cash demand has fallen in all five countries.

The paper builds on, and contributes to the literature on currency demand, the cash paradox and the seasonal method, as explained above. It is structured as follows: Section 2 introduces the seasonal method. Section 3 presents the data and estimation results and relates them to what can be inferred from the share of large denomination banknotes in total currency in circulation. Section 4 explains and rationalizes the differences between the countries from an institutional and policy perspective. Section 5 summarizes and concludes.[2]

2. The seasonal method

The seasonal method uses accounting identities and the presumption that there should be more seasonality in cash held for transaction purposes (*transaction balances*) than in cash held for non-transactional purposes (*hoarding balances*).

The starting point of the method is the decomposition of a time series Y into its trend T, the seasonal component S as well as cyclical and irregular parts. For simplicity we will attribute the cyclical and irregular components to the trend such that

$$Y = T + S.$$

The components can be transformed into multiplicative factors by dividing them by the trend T. Let the *seasonal factor* in period t be $s_t = S_t/T_t$ where S_t and T_t are the seasonal and trend components in period t. We then get the identity

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[2] A final note on terminology. We use the terms "cash demand for non-transactional purposes", "non-transactional cash demand", "hoarding demand" and "hoarding" interchangeably depending on the context.

(1) $$Y_t = T_t(1 + s_t).$$

Next, we apply (1) to the aggregate, transactional and hoarding balances and use the fact that the aggregate cash balance per definition is the sum of the transaction and hoarding balance. Denoting the respective trends and seasonal factors of the aggregate, transaction and hoarding balances with superscript *A, TR, H,* we get

(2) $$s_t^A T_t^A = s_t^{TR} T_t^{TR} + s_t^H T_t^H.$$

Let $ß_t$ denote the fraction of the transaction balances trend in the aggregate trend. This yields

(3) $$s_t^A = \beta_t s_t^{TR} + (1 - ß_t)s_t^H.$$

This accounting identity is the starting point for the seasonal method. If we have estimates of all of the seasonal factors, the transaction shares $ß_t$ and the hoarding shares $(1 - ß_t)$ can be derived from (3). However, while the seasonal factors for aggregate cash in circulation (s_t^A) can be calculated with standard seasonal adjustment procedures, we cannot directly infer the seasonal factors for the transaction and hoarding balances from the cash data. We will therefore have to use some proxies.

While there are reasonable proxies for the seasonal factor of the transaction balance (to be explained below), it is harder to find and argue for hoarding balance proxies. Following the literature using the seasonal method we assume that hoarding balances have no seasonality, i. e. $s_t^H = 1 \ \forall \ t$. (3) will then yield the equation

(4) $$\beta_t = \frac{s_t^A - 1}{s_t^{TR} - 1}$$

for the unknown value β_t.

However, equation (4) does not always produce meaningful results. If, for example, there is no seasonal fluctuation in any given period, i.e. $s_t^A = s_t^{TR} = 1$, (4) is indeterminate. Moreover, if the seasonality of total cash in circulation is more pronounced in some periods than that of transaction balances, interpretation problems occur as $\beta > 1$. And finally, depending on both seasonals, $\beta < 0$, is also possible. Thus, (4) produces plausible results for some, but not all frequencies.[3]

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[3] Some of these challenges arise from the assumption that hoarding balances have no seasonality. If we had "optimal" proxies for the hoarding balances, we could have used equation (3) to calculate the shares. While that could be an interesting extension of the method, it has not yet been done as far as we know. We have not found any good proxy for hoarding balances and follow the standard approach and assume that hoarding balances have no seasonality. Notice, however, that if there is seasonality in hoarding then our results under-estimate the hoarding balances.

We therefore implement further modifications. Fairly accurate estimation results can often be obtained only for a certain frequency within a given year. We use the fact that seasonal fluctuations in the aggregate cash balance and in the proxies are usually greatest around Christmas and lowest at the beginning of the year (usually in February). In order to factor this into (4), we replace the time index t by $[m,j]$, where m denotes the month and j the respective year. If equation (4) for February is subtracted from the corresponding equation for the preceding December, the share β_j is

(5) $$\beta_j = \frac{s^A_{dec,j} - s^A_{feb,j+1}}{s^{TR}_{dec,j} - s^{TR}_{feb,j+1}}.$$

Equation (5) implies that we rely on the seasonal highs and lows in our sample. However, it also means that there are data points from each year that we do not utilize. Alternatives to equation (5) have been used in, e.g., Seitz (1995) and Porter & Judson (1996). However, utilizing the seasonal high and lows by equation (5) has proven to yield the most reliable and successful results.

To use (5) to estimate the unknown value β_j, we need a proxy for the unknown seasonal factors of the transaction balance s^{TR}_t. In our estimations in Section 3 we try different alternatives.

a) Variables that measure cash transactions, as, e.g., retail sales or private consumption expenditures.
b) Banks' holdings of vault cash.
c) Banknotes which predominantly are used for transactions.
d) Other variables which might co-vary with transaction balances, e.g., demand deposits or the consumer price index.

The motivation with respect to b) is that banks incur opportunity costs of cash balances held. They therefore keep them to a minimum and those held stem almost exclusively from regular transactions. Hoarding for store-of-value purposes should therefore have virtually no impact on the seasonality in banks' cash balances and the seasonal component of vault cash should be more pronounced than that of total banknotes in circulation.[4]

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[4] If this assumption does not hold true, transaction balances would be over-estimated. For instance, this might be the case if negative interest rates prevail.

3. Dataset and estimation results

3.1. Data

We have compiled an (unbalanced) panel dataset for five countries: Canada, Denmark, Iceland, Norway and Sweden. The starting point of the time series varies depending on data availability for the respective country. The earliest starting point is 1990 (Sweden), the latest 2002 (Denmark). We have data up to the first quarter of 2021 for Canada, Denmark and Norway. For Sweden and Iceland, the data end in the first quarter of 2022. Our time series are on quarterly or monthly frequency.

In addition to total CiC for all five countries, we have time series for different denominations for all countries except Iceland. The proxy variables under alternative a) are retail sales and private consumption spending. We have data for vault cash (proxy variable b) for all countries and data on small denominations (proxy variable c) for all countries except Iceland. As proxy variables under alternative d) we use demand deposits and the consumer price index. The CiC and vault cash series are from the respective national central banks. Data for the other variables are collected from Macrobond and the websites of national central banks and national statistical agencies.

Table 1 gives a more detailed overview of our data availability and sources. All original series are unadjusted. We use Eurostat's software JDemetra to calculate the seasonal factors using the X12-ARIMA method.

Table 1: Data availability and sources

	Canada	*Denmark*	*Iceland*	*Norway*	*Sweden*
Total Cash	95Q1-21Q1 BoC	02M01-21M02 DNB	94M01-22M05 CBI	98M01-21M05 NB	90M01-22M06 Riksbank
Cash denominations	95Q1-21Q1 BoC	02M01-21M02 DNB	n.d.	98M01-21M05 NB	90M01-22M06 Riksbank
Retail sales	91M01-21M07 Stat. Canada	00M01-21M05 Macrobond	n.d.	00M01-21M07 Stat. Norway	91M01-22M05 Stat. Sweden
Private cons. spending	90Q1-21Q1 Macrobond	90Q1-21Q1 Macrobond	95Q1-22Q1 Stat. Iceland	90Q1-21Q1 Macrobond	90Q1-22Q1 Stat. Sweden
Vault cash	95Q1-21Q1 BoC	02M01-21M02 DNB	94M01-22M05 CBI	98M01-21M04 NB	90M01-22M05 Riksbank
Demand deposits	90M01-21M07 BoC	02M01-21M02 DNB	94M01-22M05 CBI	96M01-21M07 Stat. Norway	98M01-22M05 Stat. Sweden
CPI	90M01-21M05 Macrobond	90M01-21M05 Macrobond	90M01-22M07 Stat. Iceland	90M01-21M05 Macrobond	90M01-22M06 Stat. Sweden

Note: BoC: Bank of Canada, DNB: Danish National Bank, CBI: Central bank of Iceland, NB: Norges Bank. n.d: no data.

Figure 1 shows the CiC trends in the five countries included in the study. To simplify cross-country comparisons, we calculate index values. The reference year for the index is 2002 (index = 100) as this is the first year with CiC data for all countries. The index value for Iceland is shown on the right axis and for the other countries on the left axis. As can be seen, Iceland, Canada and Denmark have had CiC increases throughout the sample period. In Norway CiC increased until 2008, then stayed constant and decreased after 2015. Sweden's CiC also increased until the financial crisis in 2008 and decreased strongly afterwards until 2017. Since then, it has increased slightly.

Figure 1: Currency in Circulation
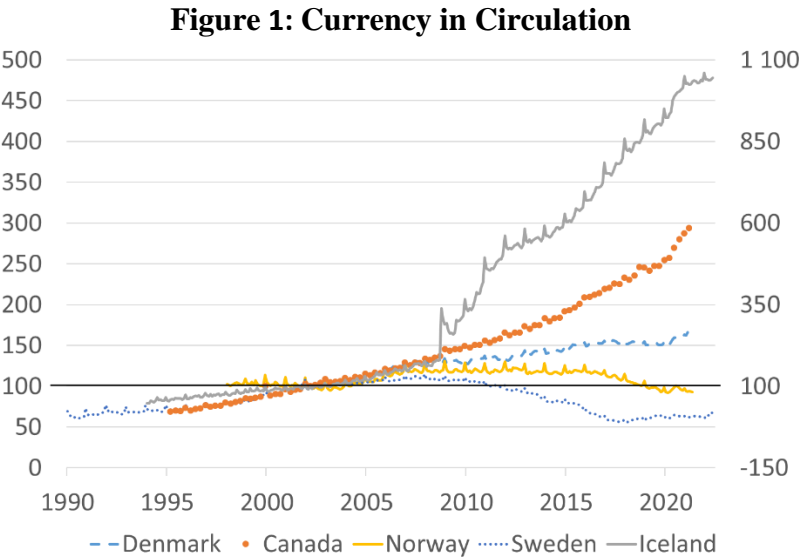
Note: Index 2002Q1=100. Index value for Iceland on the right-hand axis.
Sources: National central banks and authors' calculations.

Comparing nominal values for CiC can be misleading as cash holdings usually increase with nominal GDP. Thus, to do a sensible international comparison we need to relate CiC to nominal GDP. This ratio is shown in Figure 2. We can distinguish two groups of countries: one with a clear cash paradox (Canada, Iceland) and another without such a paradox (Norway and Sweden). In Denmark, the development has been more stable when assessed over the whole sample period. But, we may confirm the paradox even in Denmark, as the cash ratio stays constant despite the digitalization of payments.

Figure 2: Ratio of currency in circulation to nominal GDP (%)
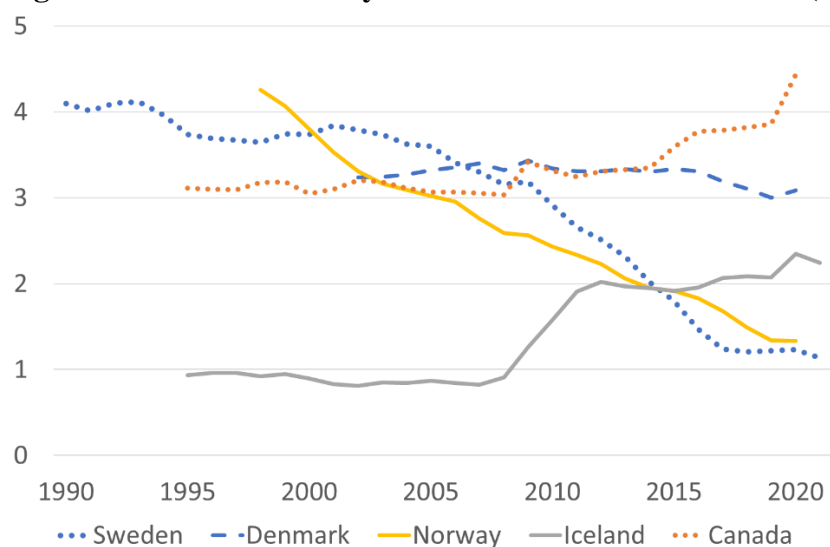
Sources: National central banks, Macrobond, national statistical agencies and authors' calculations.

While the development is strikingly similar for the countries without a paradox, it is quite dissimilar for the countries with a paradox. In Denmark, the cash to GDP ratio stayed more or less constant between 3 and 3.5 %. In Iceland, the ratio has risen drastically from a very low level to a still relatively low one between 2 and 2.5 %. Canada's ratio stayed constant until 2008, but has increased sharply three times since then. Interestingly, the increase in both Canada and Iceland started after the great financial crisis in 2008, a phenomenon observed in many other countries, as documented in e.g., Ashworth & Goodhart (2020) and Rösl & Seitz, (2022a).[5] We return to this point in Section 4 when we discuss reasons for differences between the countries.

As noted in the introduction, many authors suggest that the cash paradox is due to increased demand for non-transactional balances. We may call this the *hoarding-hypothesis*. To find support for this hypothesis they refer to the increasing share of large denomination banknotes in CiC. Figure 3 shows these shares for the four countries for which the denominational breakdown is available. As there is no unambiguous way to draw the borderline between small and large notes we include two variants. In the first variant we define the 500 kronor (SEK, NOK, DKR)/50 CAD note as large denominations. In the second variant, we include these in the group of small denominations. It is quite striking how the patterns depend on these variants. However, the hoarding hypothesis is supported for Canada in both variants. For Norway, the

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[5] Before the financial crisis, the ratio of cash to GDP in Iceland was below 1 %, the lowest ratio worldwide (Central Bank of Iceland; 2018, p.19).

non-transactional balances have declined, no matter which variant is used. In Denmark and Sweden, it depends on the classification used and time periods considered.[6]

Figure 3: Share of large banknotes to Currency in Circulation (in decimal)

A.   500 kr./50 dollar note count as large note   B.   500 kr./50 dollar note count as small note

- - Denmark   • Canada   —Norway   ⋯⋯ Sweden
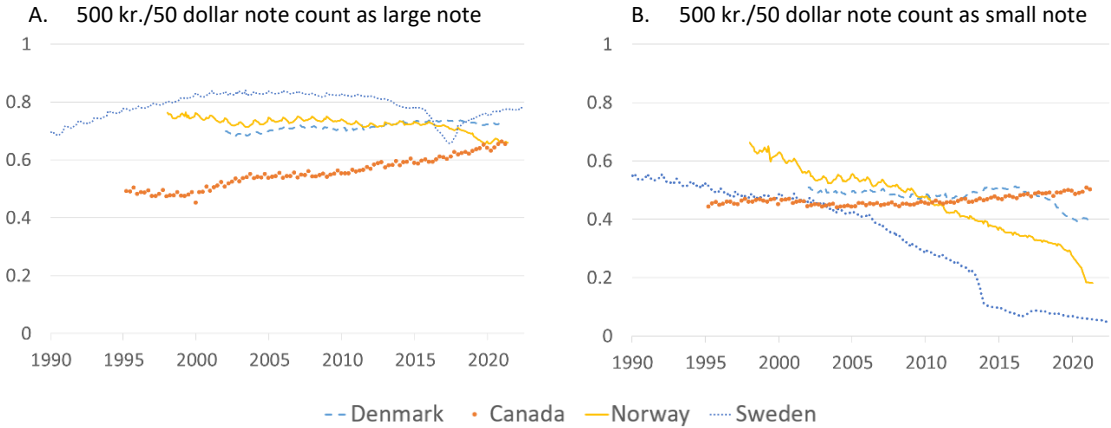
Source: Authors calculations.

We will now turn to our estimations and analyse what conclusions can be drawn from the seasonal method – which does not rely on the split into denominations – about the developments in transaction and hoarding balances.

3.2. Estimation results

The implementation of the seasonal method yields sensible estimation results for all countries, but not for all proxy variables. Missing results are due to non-availability, poor quality of data, or strange seasonal amplitudes. The latter is, for instance, the case for demand deposits in all countries and for vault cash in Canada, Iceland and Norway.

Figure 4 gives an overview of the final estimation results in terms of the share of hoarding balances to total CiC ("*hoarding share*").

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[6] Rösl & Seitz (2022c) show that there is a shift in cash demand for non-transaction (hoarding) purposes over time towards smaller denominations.

Figure 4: Estimated hoarding shares (in decimal)
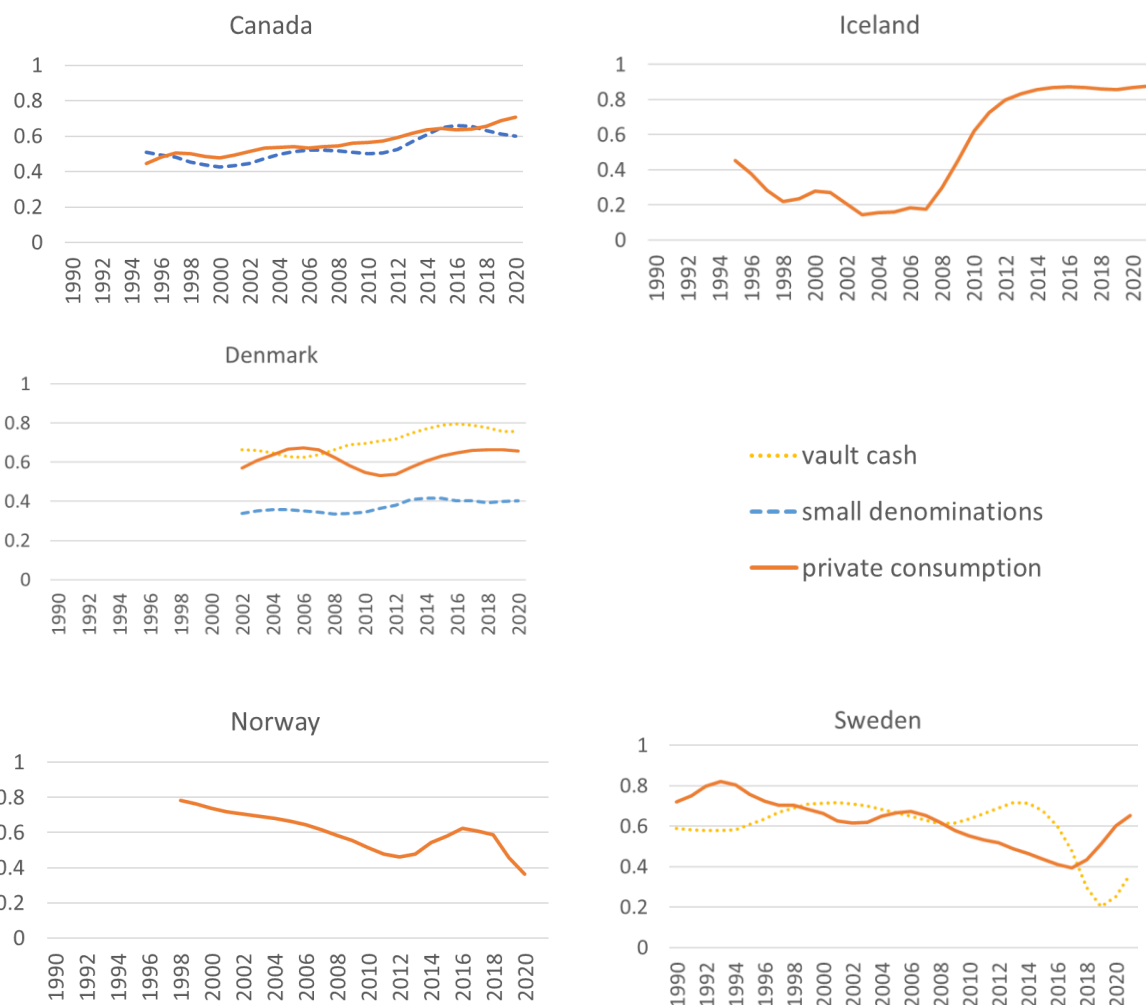
Note: Ratios of estimated transaction and hoarding balances to total CiC in %.
Source: Authors calculations.

All the estimates support the hoarding-hypothesis: For all countries with a cash paradox (Canada, Iceland and Denmark), there is also an increase in the hoarding share although the increase is small in the case of Denmark. For Iceland the rise is quite dramatic. From having a very low hoarding share in the beginning of the sample period, Iceland has the highest hoarding share among our countries by the end of the sample period (over 80 %).[7] We examine this observation for Iceland more closely in Section 4. In the case of Canada, the two estimated shares are very similar, and both show an increase over the sample period (up to between 60 and 70 %). For Denmark the estimates differ, but they all point to a small increase over the sample period. Estimated shares at the end of the sample vary between 40 % and 75 %.

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[7] This is in line with the observation that cash transactions has long constituted only a small share of domestic retail payments (Central Bank of Iceland, 2018, ch. III).

In the two countries without a cash paradox (Norway and Sweden), the estimations reveal falling hoarding shares. At the end of the sample, the hoarding share in Norway is around 40 %. In the case of Sweden, both estimates indicate that there has been a decline over the sample period. However, the Swedish shares show a quite different pattern (between 40 % and 60 %), depending on the variant used. At the end of the sample, both estimates point to an increase in the hoarding share.

Figure 5 shows what these shares imply for the ratios of transaction and hoarding balances to nominal GDP. We denote these ratios the "*transaction ratio*" and the "*hoarding ratio*", respectively. These ratios are (arguably) the preferred measures as they correct for the fact that nominal GDP increases over time. We have calculated these ratios from the hoarding shares based on the consumer spending proxy. This proxy gives plausible results for all countries. Moreover, we expect the seasonality in cash-based consumption expenditures to resemble the seasonality in total private consumption expenditures.[8] In the figure we also show the ratios of small and large denomination banknotes to nominal GDP. We base these ratios on the division between small and large notes as in Figure 3A, i.e. the broad definition of *"large",* and denote them the "*small denomination ratio"* and the *"large denomination ratio"*, respectively. These latter ratios are missing for Iceland due to non-availability of data.

A first observation from Figure 5 is that the hoarding ratios and the large denomination ratios show a remarkably similar development but at slightly different levels. The hoarding ratios are generally smaller than the large denomination ratios, and the transaction ratios are consequently generally higher than the small denomination ratios. This is in line with what we would expect if people use some large denominations also for transactions and some small denominations for non-transaction purposes, see, e.g., Rösl & Seitz, (2022c).

A second observation is that the transaction ratios and their evolution over time are quite similar between the countries. The transaction ratios are trending downwards although there are variations over the sample period with periodic increases. For all countries, the transaction ratios are lower at the end of the sample period than at the outbreak of the great financial crisis in 2008.

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[8] The results with the other proxies are available upon request.

Figure 5: Estimated transaction and hoarding ratios together with small and large denomination ratios
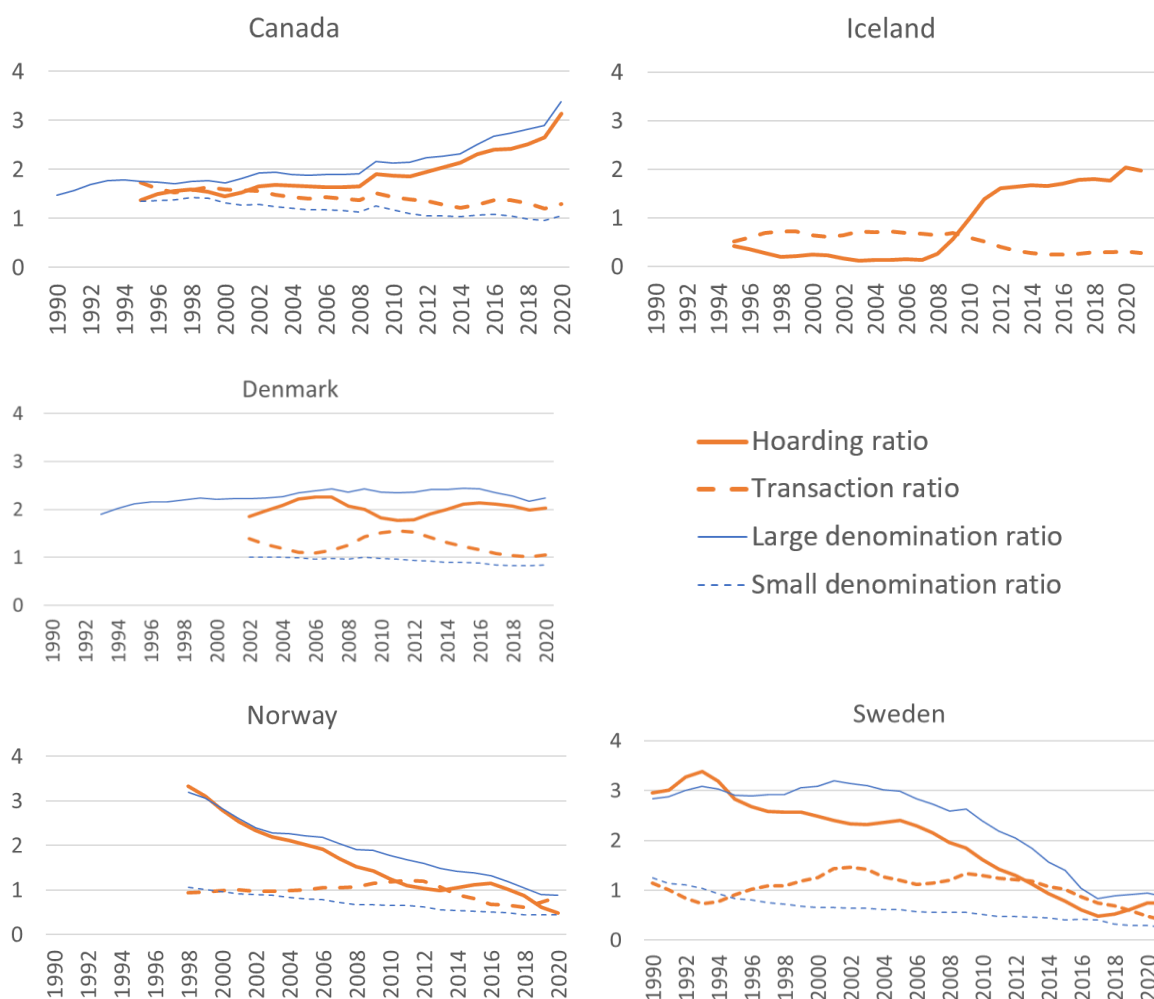
Note: Ratios of estimated transaction and hoarding balances to nominal GDP and ratios of small and large denominations to nominal GDP in %. Large denominations: Denmark: DKR 500-1,000; Sweden: SKR 500-10,000; Norway: NOK 500 and 1,000; Canada: CAD 50 and 100.
Source: Authors' calculations.

A third observation is that there are dramatic changes and notable differences in the hoarding ratios throughout the sample period. The countries with the highest hoarding ratios at the turn of the century (Norway and Sweden) have the lowest ratios at the end of the sample period. By contrast, the three countries with the lowest hoarding ratios at the turn of the century (Canada, Denmark and Iceland) have the highest hoarding ratios at the end of the sample period. The differences in the end-of-period hoarding ratios are substantial. Canada has the highest hoarding ratio (at above 3 %), more than one percentage point higher than in Denmark and Iceland, and about three percentage points higher than in Norway and Sweden.

We can conclude that according to our estimations, the increased cash-to-GDP ratios in Canada and Iceland (Figure 2) are due to increased hoarding. Thus, the hoarding hypothesis is

confirmed for Canada and Iceland. Interestingly, and partly surprisingly, the fall in the cash-to-GDP ratios in Norway and Sweden is first of all also due to falling non-transactional cash demand.

3.3. Robustness of our results

Our estimates are uncertain by nature, like any estimates. However, in our case there is no obvious way to quantify this uncertainty by, for instance, confidence bands. This is due to the fact that our estimates are not econometric estimates, but rather derived from accounting identities and the assumption that there is no season in non-transactional cash balances (see Section 2). We are not aware of any studies based on the seasonal method that calculate confidence bands. Previous studies typically take uncertainty into account by using different proxies (as we do) or/and by adding and comparing the results from other methods (see e.g. Lalouette et al., 2021 or Bartzsch et al., 2011a, b).

In this paper we have tried different proxies and to the extent that they produce plausible results, the results are quite similar (see Figure 4). Furthermore, the comparisons of our estimated ratios and the ratios based on small and large denominations (see Figure 5) suggests that the results are meaningful and robust.

4. Discussion

As noted above, it is first of all differences in the demand for cash for non-transaction purposes ('hoarding') that explain the different developments in cash between the countries. In this section, we discuss possible explanations for the differences in cash hoarding between the countries.

Different legal tender status and validity of cash

Notes and coins are de jure legal tender in all of our countries. However, de facto there are large differences.

First, practices regarding the validity of older banknotes differ. In Canada and Denmark, older banknote series are generally valid.[9] In Iceland, Norway and Sweden, older banknotes become

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[9] In Denmark all banknotes issued after 1945 are still valid. In Canada, amendments to the Bank of Canada Act and the Currency Act approved by Parliament in 2018 gave the Government of Canada the power to remove legal tender status from bank notes, something it could not do before. Consequently, in January 2021 some more than two decades old banknote series became invalid.

invalid shortly after new banknote series have been introduced.[10] These practices have been particularly strict in Sweden since 2013 and in Norway since 2017, when old notes have become invalid about one year after new notes have been introduced (Armelius et al., 2022, Norges Bank, 2019).

Strict practices regarding the validity of older banknotes are likely to reduce cash hoarding as it introduces a risk that hoarded cash that lie idle may become invalid and worthless. Thus, the lower hoarding ratios in Norway and Sweden may be related to the relatively strict note and coins changeover practices in Norway and Sweden. This hypothesis finds support in Figure 3b where we can detect a marked decline in the demand for 1000 krona notes during the recent strict changeover periods where these notes were exchanged for new ones (in Sweden 2013-2016 and in Norway 2019-2020). This is in line with a marked decline in the estimated hoarding shares (Figure 4) and ratios (Figure 5) in Norway and Sweden starting in these periods. Notice also that in Sweden there is a rebound in cash hoarding after the notes and coins changeovers.

Second, the degree of acceptance of cash payments at the point of sale (POS) differs between the countries. While these differences are less clear-cut and harder to pinpoint, Sweden and to some degree Norway stick out. Swedish businesses and authorities are in practice not required to accept cash payments, and the share of businesses that accept cash has declined over the last decade. The most recent survey found that 12 % of stores do not accept cash (Svensk Handel 2022). We assess the decline to be even more pronounced among the service providers as it has become rare for hotels, restaurants and public transport to accept cash payments. In Canada, only 3 % did so (Welte & Wu, 2023). The acceptance rate in Denmark should be at least as high as in Canada as Danish regulation specifies that cash must generally be accepted at the POS (Danmarks Nationalbank, 2022). The situation in Norway more closely resembles the situation in Sweden where more and more retailers and service providers no longer accept cash (Norwegian Ministry of Justice and Public Security, 2022). In Iceland, there seem to be only few examples of non-acceptance of cash by retailers (Central Bank of Iceland, 2018).

The lower acceptance rate for cash in Norway and Sweden may lower the demand for cash for transactions, but it is also likely to negatively influence hoarding demand. This is because there

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[10] Invalid notes are usually redeemable for some period, but the process of redeeming old notes may be cumbersome. It often requires a fee, documentation of origin, delivery at specific geographical locations, etc. In Sweden the notes can only be redeemed at the Riksbank office in Stockholm and for a fee. In the other countries older notes can be redeemed at several geographical locations and often without a fee. More detailed information can be found on the respective central bank's webpage. Engert et al. (2019) describe the differences between Canada and Sweden.

is less incentive to hoard cash for non-transaction purposes if it cannot later be used for payments.

Differences in foreign demand for the countries' cash

Foreign demand for domestic cash will show up as hoarding in our estimates (see, e.g., Assenmacher et al, 2019, Section 5) as foreign demand will also dampen the seasonal (amplitudes) in CiC.

We have no reason to believe that there has been any significant foreign demand for Scandinavian banknotes (see also Engert et al., 2019). However, there obviously has been significant foreign demand for Canadian banknotes during our sample period.

Flannigan & Parsons (2018) report evidence suggesting significant foreign demand for Canadian banknotes. Based on liaison with the cash industries in Canada they estimate that shipments of CAD 100 banknotes to Hong Kong accounted for about 5 % of all CAD 100 banknotes on issue in 2016, significantly increasing growth in banknotes in circulation that year. Proxies for foreign demand are also present and significant in their estimated banknote demand functions for CAD 100 notes, especially post-2010. Engert et al. (2019) discuss Canadian cash demand and argue that there is likely to be significant foreign demand, but notice that the reasons for this foreign demand are not well understood.

To provide some further evidence of foreign demand for Canadian notes, we again apply the seasonal method. But now we compare the seasonal of Canadian CiC with that of a reference country without foreign demand for its currency, in our case Norway.[11] As the seasonal fluctuation in cash in Canada is more dampened compared to Norway this allows us to calculate the foreign part of Canadian CiC.

Figure 6 shows the estimated foreign share together with the estimated total and domestic hoarding share (from Figure 4). The estimates suggest that the increased total hoarding share from 2007 to 2015 was driven by increased foreign demand. Since 2016 foreign demand abated. In terms of total cash demand, our estimates suggest that in 2015 as much as 25 % came from foreign demand. In 2020, it had fallen to 6 %. Domestic hoarding decreased from around 50 % of total CiC in 2007 to 40 % in 2015. After 2015 it increased to 65 % of CiC in 2020.[12]

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[11] The seasonal method turned out to yield plausible estimates only with Norway as the reference country and for the period starting in 2007.

[12] Lalouette et al. (2021, 29) find a similar pattern over time for net shipments of euro banknotes abroad.

Figure 6: Demand for Canadian dollars from abroad, total and domestic hoarding
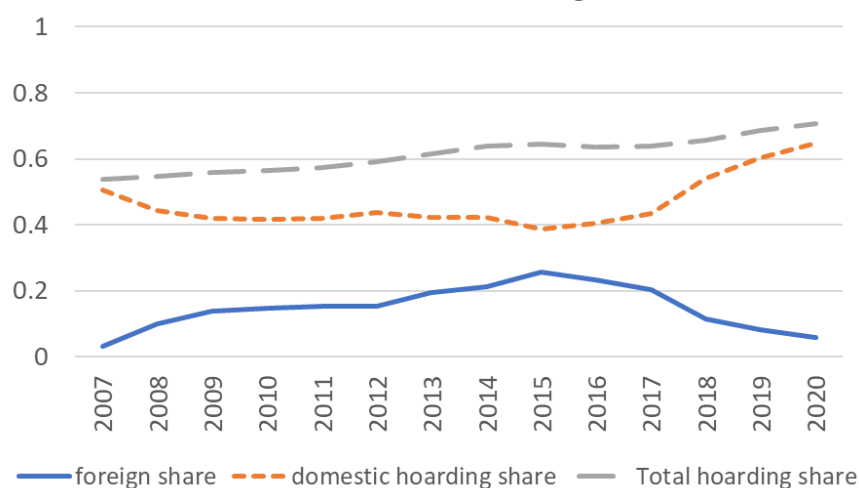
Note: Shares relative to total currency in circulation in decimal.
Source: Authors' calculations.

Different crisis experience

In times of perceived enhanced risks and uncertainty, people may move their money out of bank deposits and into secure central bank money (especially large denomination notes).[13] Bech et al. (2017), for instance, find a structural break in cash demand for advanced economies during the onset of the great financial crisis. Rösl & Seitz (2022a) show that large denomination notes are comparatively more in demand in times of enhanced uncertainty regarding the financial and/or general economic development than in other types of crises. Furthermore, Rösl & Seitz (2023) present evidence that the type of crisis/uncertainty determines whether the demand for small or large denominations increases and whether it refers to domestic and/or foreign cash.

The increased hoarding ratio in Iceland from 2008 is clearly related to this phenomenon. In October 2008 a systemic banking crisis broke out in Iceland. A considerable amount of cash was withdrawn from the banking system and placed in safety deposit boxes or stored in other places already in the run-up to the crisis (Bank of Iceland, 2009). By the end of the year CiC had increased by more than 60 %. This surge in cash holdings continued for some years and by the end of 2011 CiC had risen by more than 200 %, see Figure 1.

Canada did not experience any banking collapse or any severe banking crisis during the great financial crisis. There was nevertheless a gradual uptick in the hoarding ratio from 2008. As explained above, this uptick appears to be due to foreign demand.

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[13] Rösl & Seitz (2022b) argue that a perfect elastic provision of cash by the central bank helps to stabilize the economy in such a situation.

There was stress in some banks in both Sweden and Norway during 2008, but that did not lead to increased cash demand (see also Rösl & Seitz, 2022a). Engert et al. (2019) and Armelius et al. (2022) suggest that experiences with previous banking crises made people confident that their bank deposits were safe. The public authorities in Norway and Sweden had proven willing and able to protect commercial bank deposits. During previous crisis situations the payment systems had been up and running without interruptions and there have been no haircuts on commercial bank deposits. However, an increased hoarding demand was also recognizable during the corona pandemic, especially in Denmark, Sweden and Canada, in line with international developments (Ashworth & Goodhart, 2020; Rösl & Seitz, 2022a).

Differences in access to cash

Small denomination banknotes are inconvenient for large payments, large gifts and for store of value. Thus, it seems plausible that hoarding will diminish when it becomes more difficult to access large denomination banknotes (see also Rösl & Seitz, 2022a).

Norway and Sweden appear to have seen the most pronounced decline and to have the lowest levels in terms of access to large denomination banknotes. While the number of ATMs per adult has increased in Canada, it has fallen in the Nordic countries. Furthermore, the levels differ – with Norway and Sweden having the lowest number of ATMs per adult.[14] Denmark and Iceland have more than twice as many ATMs per capita as Norway and Sweden. Another important difference is that denominations above 500 krona (approximately 50 euro) are not available in Norwegian and Swedish ATMs. Some Canadian ATMs dispense CAD 100 notes (Engert et al., 2018). Similarly, some Danish banks dispense 1000 DK notes. We have no information for Iceland.

Furthermore, there appears to be less access to banknotes at bank branches in Norway and Sweden than in the three other countries. Norway and Sweden have the lowest number of bank branches per adult. Additionally, banks are reducing their over the counter (OTC) cash services underscoring the importance of ATMs further. Cashless branches were introduced in 2010 in Sweden and by 2012 around 40 % of the branches did not offer any OTC cash services. Today banks have stopped providing cash OTC services with only a few exceptions for some small local banks. The situation is similar in Norway. The development has been less dramatic in Canada and Denmark.

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[14] The data source is IMF Financial Access Survey and dates back to 2004.

The limited range of denominations accessible through ATMs together with the winding down of OTC cash services left the population in Sweden and Norway with only few ways to access the highest denominations in contrast to Canada and Denmark. Thus, these supply factors restricting access to large denomination banknotes may have played a role in reducing cash hoarding in Norway and Sweden.

Shadow economy

Some empirical literature find a relation between cash demand and crime, the size of the shadow economy and tax evasion, see e.g. Amromin & Chakravorti (2009), Arango-Arango & Suárez-Ariza (2019), Jobst & Stix (2017), Seitz et al. (2020). To the extent that the seasonality in the demand for cash for these purposes is unrelated to the seasonality in our proxy variables, such cash demand will show up as hoarding in our estimations.

However, there seems to be little difference between our countries in this respect (see Figure 7). An update of the shadow economy estimates of Medina & Schneider (2018) show a similar (downward) evolution over time in our five countries. Moreover, and especially since the great financial crisis 2008, the levels are quite comparable in Denmark, Sweden, Norway and Iceland.

Figure 7: The share of the shadow economy in GDP (in %)
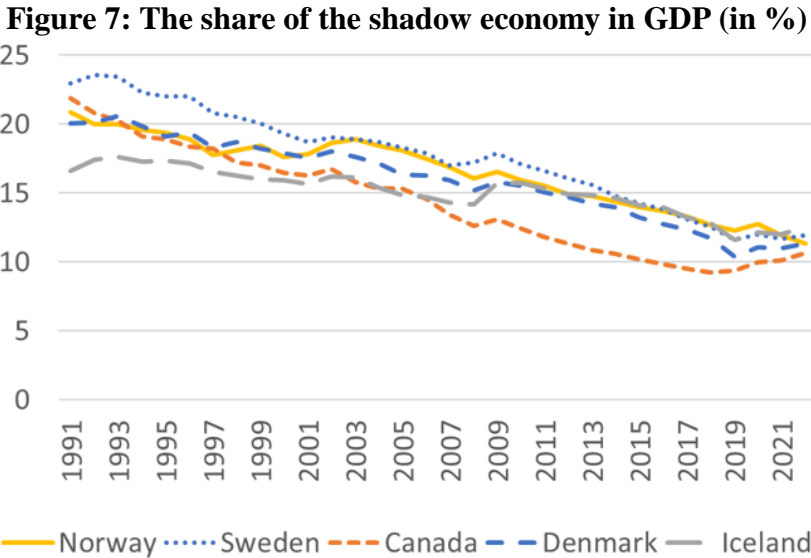
Source: Update of Medina & Schneider (2018).

Summary and Conclusion

Despite a similar ongoing trend towards digital payments, Norway and Sweden have seen a decline in cash holdings relative to GDP while Canada, Denmark and Iceland experienced an increase. Our empirical analysis suggests that the differences between cash demand in these countries is due to differences in cash hoarding, i.e., cash used for non-transactional purposes,

not to differences in transactional cash demand. Cash hoarding has declined significantly in Norway and Sweden, while it has increased significantly in Canada and Iceland and slightly in Denmark. All five countries have seen a decline in the demand for cash for transactional purposes.

With respect to potential explanations for the divergent developments, we found some empirical and casual support for the following hypothesises. In Canada hoarding increased after the great financial crisis as foreign demand for CAD rose sharply. However, the more recent increase in Canada is harder to explain. In Iceland the dramatic cash hoarding increase between 2008 and 2013 seems to be due to the fact that Iceland was severely hit by the great financial crisis. But, we should also notice that the use of cash was very low in Iceland before the 2008 crisis, and that despite the rapid increase in cash demand, it is still very low compared to other countries. In the case of Norway and Sweden, weak legal tender status of cash and quite aggressive notes and coins changeovers as well as restrictive access to cash, i.e., supply-side factors, may have been important drivers of the decline in cash hoarding.

The primary motivation for this paper was the idea to gain a better understanding of the strong decline in cash in Sweden. Previous papers found evidence suggesting that Sweden is special rather than ahead of other countries (Engert et al., 2018; Armelius et al., 2022). Arguably and at first sight, our findings are less supportive of this view. All countries in our sample have seen a decline in transactional cash demand. Furthermore, the countries that have seen increased hoarding appear to have been hit by country-specific shocks (domestic financial crisis and foreign demand for banknotes). However, the negative supply-side effects are special to Sweden (and Norway).

Understanding the role of cash for non-transaction purposes, and especially for store of value, is important for several reasons. First, it is important for banknote design, production and provision. If cash is used for store-of-value purposes, that may support the issuance of large denomination notes. Second, banknotes used for store of value do not wear and tear as fast as banknotes used for transactions. It also suggests that central banks and lawmakers should make sure that an appropriate infrastructure is in place such that it is also possible to withdraw, exchange and deposit large denomination banknotes. Third, the importance of cash for store-of-value purposes may have implications for the design of a prospective central bank digital currency (CBDC). If store-of-value purposes are important, CBDC should (arguably) also be designed such that it can be used for store-of-value purposes.

A future extension of this work would be to see if it is possible to provide more firm empirical support for the potential explanations and our conjectures discussed in Section 4. One approach might be to use the estimated hoarding and transaction cash balances and not total CiC in empirical cash demand equations where the explanatory variables should be hoarding and transaction cash demand specific. We leave this for further work.

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