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Abstract

I use data from the Bank of Canada's Bank Note Distribution System and exploit a natural experiment offered by the timing of Easter in the Gregorian calendar to analyze the effects of demographic change for currency demand. I find that the main drivers of low-denomination bank note demand are merchants. Merchants and the youngest age group, aged 15-24, are also a significant source of demand for twenty-dollar bank notes and for the total dollar value of withdrawals. In contrast, increases in the demographic age groups 25-54 and 55 plus tend to lower bank note withdrawals. Finally, I find no evidence that employment status is related to bank note demand, but that there is a difference between the bank note demand of men aged 15-24 and women aged 15-24: increases in the share of women aged 15-24 lead to increases in bank note demand.

JEL classification: E41, C31, C36
Bank classification: Bank notes; Econometric and statistical methods

Résumé

L'auteur s'appuie sur une expérience naturelle offerte par les fêtes de Pâques (dans le calendrier grégorien) pour analyser les effets de l'évolution démographique sur la demande de numéraire à partir des données fournies par le Système de distribution des billets de banque de la Banque du Canada. L'étude montre que les détaillants sont le principal moteur de la demande de petites coupures. Une part importante de la demande de billets de 20 dollars, de même que de la valeur totale des retraits, provient des détaillants et du plus jeune groupe d'âge (les 15-24 ans). En revanche, l'accroissement des groupes d'âge des 25-54 ans et des 55 ans et plus tend à réduire les retraits de billets de banque. Enfin, rien ne permet de penser d'après l'étude qu'un lien existe entre la situation d'emploi et la demande de billets de banque, mais l'auteur constate une différence concernant la demande de billets de banque entre les hommes et les femmes du groupe des 15-24 ans. Une augmentation de la proportion de femmes âgées de 15 à 24 ans se traduit en effet par une hausse de la demande de billets de banque.

Classification JEL : E41, C31, C36
Classification de la Banque : Billets de banque; Méthodes économétriques et statistiques

1 Introduction

Recent advances in payment technologies have expanded the choice sets of consumers when it comes to the method of payment they wish to utilize for a given transaction. At the vast majority of points-of-sale, consumers can choose between cash, debit cards, credit cards, merchant loyalty cards and programs, and even digital currencies. One is rightly tempted to wonder: Is the end of cash near?

There are many reasons to suspect that cash is susceptible to competition as a method of payment. Cash can be awkward or costly to obtain at a reasonable price, even if a bank or automated teller machine (ATM) is readily accessible. Cash can be unwieldy and unsafe in large amounts and is susceptible to counterfeiting. Cash also does not earn interest, and realistically cannot, and so is typically dominated in terms of its rate of return by other payment choices.

However, there are also reasons to suspect that cash will remain a widespread method of payment. Cash, unlike digital transactions, provides a certain measure of anonymity. Unlike debit (and, to some extent, credit) cards, cash does not expose consumers to the risks that important financial account information may be compromised. Unlike gift cards, cash is readily accepted at virtually all merchants and thus consumers are free to shop for competitive prices. Finally, unlike digital currencies and electronic payments, cash is resilient to technological hiccups. Perhaps more importantly, there is no obvious evidence that the demand for cash is falling. Arango, Huynh and Sabetti (2011) examine the effect of incentives at the point-of-sale using diary data and find that cash remains a popular choice of payment instrument for low-value transactions. Bagnall *et al.* (2014) examine cash usage in seven countries using harmonized diary data and find evidence of cash usage in all of the countries examined. Finally, in Canada, as in many developed nations, the value of notes in circulation as a fraction of GDP has remained largely stable since the 1990s.

Individual cash holdings are private information and so it can be difficult to determine the forces driving the demand for cash. Are youth less likely to demand cash than older Canadians? How does employment matter? How stable is money demand across demographic cohorts? Theoretically, there are plausible reasons to believe that demography may affect the demand for cash. Miller and Orr (1966), Whalen (1966) and Frenkel and Jovanovic (1980) argue that the demand for cash balances depends in part on precautionary motives and transactions costs, both of which plausibly depend on age. More recently, Fischer (2014) estimates the effect of immigration on the demand

for large-value notes across cantons in Switzerland, and finds evidence that immigration patterns affect the demand for such notes. Fischer avoids endogeneity biases by using settlement patterns of previous immigrants as instrumental variables, following Card (2001). Finally, there is evidence that demographic variables may help to predict payment method choices by consumers. Similarly, Jankowski *et al.* (2007) examine the demand for bank note denominations in Chicago using cash orders from bank branches and socio-economic data by zip code to evaluate the effect of immigration on bank note demand. Borzekowski and Kiser (2008), Borzekowski, Kiser and Ahmed (2008) and Klee (2008) report that age is a significant predictor of debit card adoption. Jiang and Shao (2014) propose a related, theoretical, mechanism for money demand if payment method options for consumers are uncertain: individuals may continue to hold cash while, in response, (unmeasured) velocity falls. Understanding the demographics of money demand is important to understand the distribution of the welfare effects of inflation. Understanding the demographics of money demand may also be informative about the transmission of monetary policy.

Estimating the effects of demography on the demand for cash is, however, challenging using either time-series or cross-sectional data.[1] The chief problem is endogeneity bias. Loosely speaking, the estimated effects of demographic changes on the demand for cash may be biased by an(y) omitted variable(s) or latent patterns that are unmodelled. Possible omitted variables include: institutional changes, such as the emergence of ATMs, that co-move with demographics such as the aging of the baby-boom generation; improvements in financial literacy that are correlated with demographic patterns; sectoral reallocations and/or income shocks that are correlated with demographic patterns; or immigration patterns that affect money demand and are correlated with demographic variables. It is useful to note that these omitted variables would plague both time-series and cross-sectional (i.e., cross-state) data. As Dunbar (2013) notes, instrumenting for demographic variables at higher than annual frequency is challenging because of the lack of variation in demographic shares at such frequencies. Nor are lagged values of demographic variables plausible instruments because of serial correlation in such shares.

To estimate the effect of demography for cash demand, I exploit a natural experiment offered by the Gregorian calendar and the work hours of the bank note distribution system (BNDS) used by the Bank of Canada. In typical years, Good Friday falls entirely in April. However, in some

[1] Indeed, the challenge appears to extend beyond the effects of demography. Friedman and Kuttner (1992) argue that time-series data are unable to find a reliable relationship between money and economic activity.

years Good Friday falls in March. The BNDS is closed on Good Friday in every region and thus financial institutions cannot withdraw or deposit bank notes on this date. (In contrast, the BNDS is open in every region on Easter Monday.) The shifting timing of Good Friday when interacted with demographic variables provides unbiased estimates of the effect of demographic change as in a difference-in-difference estimation.

One may then wonder exactly how does shifting the timing of Good Friday affect financial institutions' demand for cash withdrawals? First and foremost, the Good Friday holiday prevents financial institutions from withdrawing cash from the Bank of Canada for three consecutive days. Normally, this occurs in April and thus shifting Good Friday from April to March effectively adds one long weekend to March and removes one from April. To the extent that the long weekend affects the pattern of demand for bank notes, one would expect financial institutions to adjust their withdrawal and deposit behaviour in response to the Easter holiday. Indeed, the evidence presented in this paper confirms this intuition, since Good Friday has a positive effect on the demand for cash withdrawals by financial institutions. Because it is costly for financial institutions to obtain cash, I show that one can manipulate a profit function for financial institutions to estimate the effect of money demand by retailers and demographic age cohorts caused by the changing timing of Good Friday.

Other possibly similar candidates for a natural experiment are the shifting day-of-week occurrence of Christmas, weather shocks or power interruptions. These events are less suitable as natural experiments for several reasons. First, the timing of Christmas occurs within the same month and thus one should ideally use daily (or at least weekly) frequency for the explanatory variables. Demographic data, which is of main interest in this paper, are not available at this frequency. Second, weather shocks or power interruptions are typically not predictable, which implies that identification would result from *ex-post* comparisons. As a consequence, identification of the demand effects may be confounded with supply interruptions in the supply of notes because of the same weather shock or power interruption.

The estimates presented in this paper suggest that the demand for currency withdrawals by financial institutions is driven largely by the 15-24 age group and by merchants. Increases in the 25-54 and 55 plus age groups lower the demand for currency withdrawals. These results hold broadly across the five-dollar, twenty-dollar and total dollar withdrawals. I consider various robustness

exercises and find that these patterns are robust to different specifications of trend demand and the inclusion of additional controls for the costs of currency acquisition, and appear to be stable over the sample period. These results appear to hold for both net and gross withdrawals. The results are consistent with some estimates of money demand based on the Bank of Canada's 2009 Methods-of-Payment Survey. Arango and Welte (2012) reported that the 18-34 age cohort had the highest frequency of cash withdrawals per month in comparison with the 35-54 and 55 plus age cohorts. They also reported that the 18-34 age cohort had the highest average monthly spending in cash.

One concern is that the shifting timing of Easter, while plausibly exogenous at an annual frequency, is non-random at the monthly frequency. For instance, in no case does Easter fall in September. To examine the robustness of the causal interpretation of the results, I estimate a set of regressions including only data for the months of March and April. While this reduces the sample size significantly, it does reduce the possibility that the results are influenced by the inclusion of inappropriate controls. The results appear to be robust to this sample selection refinement. As a second robustness exercise, I use variation in the number of working days per month instead of the shifting timing of Easter as the interaction term. This channel is, in some respects, quite different than using variation in the timing of Easter, insomuch as the differences in the number of working days may imply difference in the days of the week. Whereas Good Friday is always a Friday, and so a financial institution is forecasting demand for an otherwise-identical three-day period, an additional (or lesser) working day can be any weekday. Nevertheless, if estimates using working-day variation provide qualitatively different demand effects, then this would cast doubt on the appropriateness of the Easter experiment. Fortunately, the results using working-day variation are qualitatively very similar to those using the shifting timing of Easter.

I consider also the effect of disaggregated age groups by employment status and gender. I find no evidence that employment status is an important driver of currency demand for any of the age groups examined. In contrast, I find some evidence that, for the 15-24 age group, women are more likely to demand cash than men. Neither of these findings suggests a cyclical or structural change in the underlying demand for cash in Canada.

Forecasting the demand for cash is a necessary function of central banks. Shortfalls in the supply of bank notes may reduce public confidence in a currency and cause disruption to the functioning

of the economy. Overproduction of bank notes is costly and reduces the seigniorage revenue of the central bank. Prudent cash management is therefore a core business function of a central bank. Yet, forecasting can be a difficult task, since models can be subject to a variety of biases, which can render forecasts based on past data susceptible to sudden changes in the underlying mechanisms that generate the data. Taken as a whole, the results in this paper suggest that a forecasting model for cash demand should emphasize its fit to the data and should not be overly concerned with the effects of endogeneity biases masking structural change in the forecasting relationships. The results in this paper suggest that the key drivers for cash demand have remained stable over the sample period and, by logical extension, that forecasts based on past data are not inherently biased by underlying structural change.[2]

The results presented here are most related to Gerst and Wilson (2011), who examine the long-term forecast for cash demand in the United States, and Amromin and Chakravorti (2009), who examine the changes in demand for different denominations of currency. The results in this paper suggest that demographic modelling may play a key role in forecasting the future evolution of the demand for currency. The results also suggest that merchants are key drivers of the demand for cash, particularly for lower-denomination notes. This finding is consistent with the observation that merchants are often required to make change for transactions.

Understanding the evolution of the demand for cash has possible implications for the conduct of monetary policy (see, for example, Friedman 1999, Freedman 2000, Goodhart 2000, Woodford 2000, Kroszner 2003, Chakravorti 2006, Alvarez and Lippi 2009). Most obviously, in many countries central bank independence is rooted in the ability of central banks to raise seigniorage revenues. If the demand for currency falls sufficiently far, the operational independence of central banks may no longer be assured, although the ability to conduct monetary policy through settlement balances would be unaffected.

[2]There is also a burgeoning literature on the methods of payment chosen by consumers. For example, Schuh and Stavins (2010) examine the adoption rates of new payment technologies using survey data and find mixed evidence that other payment methods reduce the demand for cash. Benton *et al.* (2007) find evidence that the adoption rates of new payment technologies do not systematically vary as much across demographic age groups as they do within. These studies examine the payment choices of individuals at the point-of-sale and not the demand for cash from the central bank by financial institutions, as is examined here.

2 The Bank Note Distribution System Data

The Bank of Canada responds to demand for bank notes from financial institutions at regional distribution centres that are roughly distributed across the Canadian provinces. The demand for new notes can be the result of a financial institution returning notes in circulation to the Bank and requesting new notes, perhaps because of concerns over a note's fitness, and/or to meet growth in demand for currency.

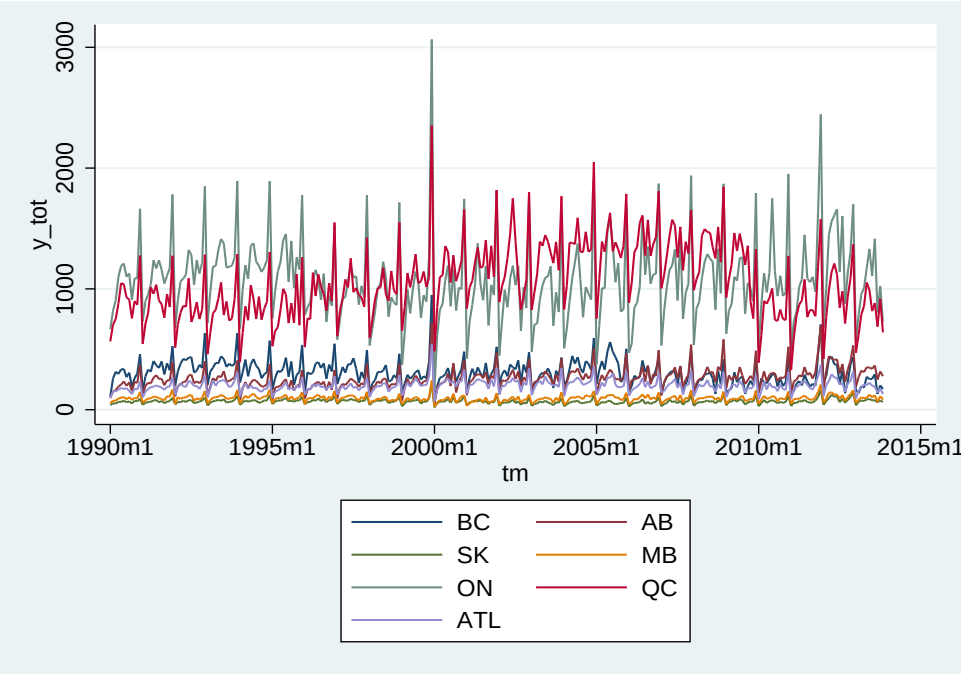
The Bank of Canada overhauled the note distribution system in 1996 with two key changes (see Bilkes 1997). First, most of the regional agency operations centres of the Bank of Canada were closed. Second, these regional centres were replaced in most cases by cash distribution centres that effectively recycle cash between financial institutions and are monitored by the Bank of Canada. The only two agency operations centres that remained were in Toronto and Montréal. Despite the closures of the regional operations centres in 1996, the Bank of Canada continues to transfer cash to, and accept cash from, the regional distribution centres operated by individual financial institutions. Thus the Bank of Canada maintained a time series of note withdrawals and deposits in seven regions over the period 1990-2013.[3] Figure 1 shows the total net withdrawal of currency by region over the period 1990-2013. As is evident in the graph, there is little trend change in the net withdrawal data over the period. There are several spikes in the data, notably in late 1999 and again in 2012. These spikes appear to coincide with Y2K concerns and with the introduction of polymer notes, respectively.

Over the period 1990-2013, the total dollar value of notes in circulation increased from $20.4 billion to $64.1 billion, an increase of over 300 per cent. The difference between the dollar value of notes in circulation and net withdrawals is simply that the former is the sum (integral) of past net withdrawals. The evidence in Figure 1 shows that the contribution of withdrawals to notes in circulation has been remarkably stable over the period 1990-2013.

The withdrawal data form the basis of the investigation in this paper. I use data from Statistics Canada's Labour Force Survey to construct demographic age groups 15-24, 25-54 and 55 plus for each of the regions for which I have withdrawal data. I also use Statistics Canada's retail sales data as a proxy for the number of businesses in each region. One concern with using retail sales is that economic activity in the underground economy may be particularly likely to use cash as a

[3]The regions are British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec and the Atlantic provinces.

Figure 1: Currency Total Net Withdrawals by Region, 1990-2013



method to evade detection. Following arguments in Dunbar and Fu (2014), I use data on housing completions as an additional proxy for underground economic activity, since cash payments in the construction sector appear to be common. Figures 4 to 8 in the appendix show the evolution of the demographic age groups, retail sales data and housing completions for each region over the period 1990-2013.[4]

3 The Demand for Cash by Financial Institutions

In this section, I present a simple stylized model to estimate the causal effects of demography for bank note demand. Consider a profit function for bank note issuance for a financial intermediary. The profit function is additively separable in components, so the realized real profit from intermediating bank notes in period t is

$$\Pi_t = n_{f,t}\kappa_f M^d_{f,t} + \sum_{i \in D} n_{i,t}\kappa_i M^d_{i,t} - M^s_t(\frac{1+I_t}{1+\pi_t} - 1) - C, \tag{1}$$

where $\kappa_f > 0$ is the real revenue from issuing bank notes, $M^d_{f,t}$, to merchants, $n_{f,t}$; $\kappa_i > 0$ is the real revenue from issuing bank notes, $M^d_{i,t}$, to a demographic age group $n_{i,t}$; D is the set of distinct

[4]The housing completions data are adjusted by the housing CPI in each region, as described in section 3.

age groups; M_t^s is the money withdrawn by the financial institution at the real cost $\frac{1+I_t}{1+\pi_t} - 1$ with nominal interest rate I_t and inflation rate π_t; and C is a fixed cost.[5] This implicitly imposes a variable cost for the financial institution to obtain bank notes from the central bank which is equal to the real interest that could be earned.

Rewriting this equation in terms of M_t^s yields

$$M_t^s \frac{I_t - \pi_t}{1 + \pi_t} = n_{f,t}\kappa_f M_{f,t}^d + \sum_{i \in D} n_{i,t}\kappa_i M_{i,t}^d - \Pi_t - C. \tag{2}$$

Suppose next that financial intermediaries choose M_t^s rationally and that there is no uncertainty over the real costs for withdrawals by the financial institution.[6] The expectation of M_t^s is

$$\mathsf{E}[M_t^s] \frac{I - \pi}{1 + \pi} = n_{f,t}\kappa_f \mathsf{E}[M_{f,t}^d] + \sum_{i \in D} n_{i,t}\kappa_i \mathsf{E}[M_{i,t}^d] - \mathsf{E}[\Pi_t] - C, \tag{3}$$

where the number of merchants and the size of the demographic age groups is assumed to be known. Since money withdrawals are a choice by the financial institution, then $\mathsf{E}[M_t^s] = M_t^s$. For ease of exposition, I assume that the expectation of real money demand is a constant plus an additive error in expectations for the financial intermediaries, so that

$$M_t^s \frac{I - \pi}{1 + \pi} = n_{f,t}\kappa_f (M_f^d + \epsilon_{f,t}) + \sum_{i \in D} n_{i,t}\kappa_i (M_i^d + \epsilon_{i,t}) - (\Pi + C) - \xi, \tag{4}$$

where, in a slight abuse of notation, M_f^d is the expected real money demand by merchants, M_i^d is the expected real money demand by demographic age group i, Π is the expected profit, ϵ's are the expectational errors on the bank note demands by merchants and age groups, and ξ is the expectational error on the forecast profit unrelated to bank note demands. (In the empirical work that follows, I test the robustness of the assumption that the expected real money demands are constant.) Straightforward rearrangement yields

$$M_t^s \frac{I - \pi}{1 + \pi} = n_{f,t}\kappa_f M_f^d + \sum_{i \in D} n_{i,t}\kappa_i M_i^d - (\Pi + C) - \xi_t + n_{f,t}\kappa_f \epsilon_{f,t} + \sum_{i \in D} n_{i,t}\kappa_i \epsilon_{i,t}, \tag{5}$$

[5] I assume that financial institutions are profit maximizing and earn positive revenue on bank note withdrawals.

[6] Although this latter assumption may seem unusual, the frequency of cash withdrawals by financial institutions is daily and the short-run nominal interest cost is the overnight interest rate. Thus, expectation errors on the real interest costs are likely to be very small, and in any event could be hedged.

which highlights the endogeneity problem because the unobserved-error component is correlated with the observed age-group sizes and the number of merchants. This endogeneity bias implies that determining the effect of demography for real money demand is non-trivial. Note that one can rewrite the error term as

$$e_t \equiv -\xi_t + n_{f,t}\kappa_f\epsilon_{f,t} + \sum_{i\in D} n_{i,t}\kappa_i\epsilon_{i,t}, \tag{6}$$

so in this interpretation the errors e_t are the total unexpected deviations from profits.

To identify the impacts of merchant and age-group demand for the financial institutions' withdrawal of bank notes requires either a set of instruments for age groups and merchants or a natural experiment that shifts bank note demand in a manner orthogonal to the expectation errors. Finding a plausible set of instruments for demographic age groups is difficult (as noted by Dunbar 2013) because there is very little variation in age-group sizes between periods, and so finding an instrument for this variation is challenging. One natural experiment is provided by the Gregorian calendar and the shifting timing of Easter between April and March. Let ε_f represent a shift in bank note demand by merchants owing to Easter, and let ε_i be the shift in demand by age group i. Finally, let ε_Π be the effect on profits from Easter. Then in a month with Easter:

$$M_t^s\frac{I-\pi}{1+\pi} = n_{f,t}\kappa_f(M_f^d+\varepsilon_f) + \sum_{i\in D} n_{i,t}\kappa_i(M_i^d+\varepsilon_i) - (\Pi + C + \varepsilon_\Pi) + e_t, \tag{7}$$

which identifies the money demand by merchants, $\kappa_f\varepsilon_f$, and the money demand for each demographic age group, $\kappa_i\varepsilon_i$, if $plim[\varepsilon_j' e] = 0,\ j = \{f, i \in D\}$. These latter assumptions are equivalent to saying that financial intermediaries are not worse at forecasting their expectations for bank note withdrawals at Easter. It is useful to note that the limiting restrictions $plim[\varepsilon_j' e] = 0,\ j = \{f, i \in D, \Pi\}$ are necessary for the Easter effect to be a valid natural experiment. Consequently, the interaction of Easter with the regressors does not imply any additional restrictions in terms of exogeneity. I caution that the money-demand effects identified are specific to the Easter period and, as with all experiments, one cannot be certain that they generalize to all periods during the year. The Easter period includes a day that would normally permit cash withdrawals, a Friday, as well as a typical period where withdrawals are not possible, a Saturday and a Sunday. The gap between withdrawal dates for an Easter weekend is therefore three days as opposed to two. To the extent that a financial institution perceives money demand by merchants and demographic groups

to be stable per day (or per weekend), the results would generalize to other similar periods during the year.

3.1 Econometric Model

I use the net withdrawal data, $M^s_{j,m,t}$, from the Bank of Canada BNDS for each region, $j = 1, 2, ..., 7$, over the period, $t = 1991, ..., 2012$, by month, $m = 1, 2, ..., 12$. I use the monthly average overnight Bank Rate, I, and the average regional monthly inflation rate, π, to calculate the real value of withdrawals:

$$m_{j,m,t} = M^s_{j,m,t} \frac{I_{m,t} - \pi_{j,m,t}}{1 + \pi_{j,m,t}}.$$

This specification implicitly assumes regional heterogeneity in the cost of obtaining bank notes by the financial institution driven by local pricing differences.[7]

I do not observe the number of merchants who demand bank notes, but I assume that n_f comprises two groups, where n_{f1} are merchants in the legal economy and n_{f2} are merchants in the underground economy. I assume that n_{f1} can be proxied by retail sales, which I obtain from Statistics Canada. I use non-seasonally adjusted retail sales following Lee and Siklos (1997) and Dunbar (2013), who argue that the process of seasonal adjustment may alter the observed relationship between variables. The assumption that retail sales proxy local economic activity would seem reasonable for legally reported economic activity, but may be biased by unreported economic activity. As a robustness check for the latter, I also include data on housing completions and housing costs following the evidence suggested by Dunbar and Fu (2014) that housing expenditures are a proxy of unreported income. To proxy the value of housing and housing production, I multiply the number of housing completions by the local consumer price index for housing costs. This series is the value-added increase in the housing sector, which I assume proxies the number of merchants in the underground economy, n_{f2}.[8] I obtain individual age-group populations, n_i, from the Labour

[7]Note that regional pricing heterogeneity introduces additional concerns regarding the possible endogeneity of demographic regressors, since errors in price indices may be correlated with demographic shares because of price competition driven by demographic tastes.

[8]Note the implicit assumption that retail sales and housing completions are not deflated by the inflation rate. I choose this specification to ensure that there is no spurious correlation owing to the same deflator being applied to the regressor and regressand. In unreported results, I examine a specification using deflated retail sales and housing completions and find statistically similar results to those reported in this paper. Indeed, as would be expected, there are more individually significant estimates using the deflated series, which suggests that some of the correlation may be due to the common deflator. Thus, I choose to report the results using nominal retail sales and housing

Force Survey data provided by Statistics Canada. I focus on three age groups: 15-24, 25-54 and 55 plus. In some of the regressions that follow, I further differentiate between the employed and the total population. I define $X_{j,m,t} = [$ retail sales, valued-added housing and the individual age groups $n_i]$ as the non-interacted demographic and merchant variables.

The econometric model specification is

$$m_{j,m,t} = \Gamma_j + \Lambda_m + \Omega_t + X_{j,m,t}\beta + X_{j,m,t}E_{j,m,t}\alpha + E_{j,m,t}\tilde{\Gamma}_j + u_{j,m,t}, \tag{8}$$

where the fixed region, Γ_j, year, Ω_t, and month effects, Λ_m, are part of the specification of the error process, $u_{j,m,t}$, and represent the expected net profits, $\Pi - C$. In this specification, $E_{j,m,t}$ is a dummy matrix for the shift in Easter. $E_{j,m,t}$ equals the identity matrix, I, in March if Easter falls in March, and $E_{j,m,t} = -I$ in April if Easter falls in March (this yields 84 dummy variables out of my sample of 1,918). Here, $\tilde{\Gamma_j}$ are the fixed effects of Easter that remain after conditioning on $X_{j,m,t}$. The coefficients β are the demographic and merchant demands potentially biased by the endogeneity concerns highlighted above, and α are the demographic and merchant demands for the Easter period.[9] I also consider a different specification of the fixed effects in the regressions by replacing the year dummies, Ω_t, with a regional time trend polynomial:[10]

$$m_{j,m,t} = \Gamma_j + \Lambda_m + \sum_j (\omega_{1,j}\tau + \omega_{2,j}(\tau)^2 + \omega_{3,j}(\tau)^3) + \phi BNDS + X_{j,m,t}\beta + X_{j,m,t}E_{j,m,t}\alpha + E_{j,m,t}\tilde{\Gamma}_j + u_{j,m,t}, \tag{9}$$

where τ is an integer time index starting at 1 for the first observation and BNDS is a dummy for the years in which the BNDS was operating. I also also include Easter fixed effects, in case Easter has a predictable effect on profits – for example, because of a lower frequency with which financial institutions can withdraw cash. An additional complication is that the errors $u_{j,m,t}$ are likely to be serially correlated, which, as noted by Bertrand *et al.* (2004), will bias the significance of the estimates of the Easter effects. Following Brewer *et al.* (2013), I cluster the standard errors by region and scale the residuals by a small-sample correction factor to compute a t-statistic that is

completions, since these are, in some sense, the more conservative estimates.

[9] I check the correlations between the Easter dummy and the included regressors, and find that they are all near zero, to ensure that the Easter effect is uncorrelated with the included regressors.

[10] When regional trends are used, I include a dummy variable for the change in the BNDS.

approximately t-distributed. Brewer *et al.* find that this approach provides tests of the correct size in the presence of serial correlation and with small numbers of groups, as is the case here.[11]

The interpretation of the estimated coefficients is slightly complicated, because they are the mean value of bank note demand times the revenue earned by the financial institution. Thus, the estimated coefficients confound profit effects from revenue differences for withdrawals with profit effects from differences in the demand for bank notes. To see this, note for example that $\alpha_j \equiv \kappa_j \varepsilon_j, \;\; j = \{i, f\}$. By assumption, $\kappa_j > 0$, so only the sign of ε_j is revealed by the estimate of α_j (the same is true for all the estimated α's). If the sign of ε_j is negative, then this implies that financial institutions reduce their withdrawals of bank notes as n_j increases. However, the magnitude of the coefficient estimates is not, in general, informative of the level of the bank note demand without further restrictions across demographic and/or merchant groups. Alternatively, one could use information on bank fees for withdrawals to calibrate the typical revenue earned from bank note withdrawals.[12]

3.2 Net Withdrawals

The baseline specification employed in this paper uses net withdrawals as the dependent variable. Table 1 reports the coefficient estimates for three denominations of withdrawals: five-dollar bills, twenty-dollar bills and total withdrawals (the sum of all denominations). Two different specifications of the trend changes are reported. In the first, individual region trends are approximated by a cubic polynomial interacted with the region dummy variables. This permits regional variation over time by restricting the functional form of the trend. In the second specification, annual year dummies are included in the regression. This permits a flexible function form for the annual trends, but restricts the shape of this function to be identical across regions.

Starting with the five-dollar regression results (columns 2-5) in Table 1, the results suggest that increases in the 25-54 and 55 plus age groups lower demand for five-dollar bills. The estimated coefficient for the interaction between the Easter dummy variable and both age groups is approximately -0.03 and significantly different from zero at the 1% level of significance. The estimated coefficients

[11] I also examine the partial autocorrelation function for the residuals from each region and these do not exhibit evidence of a significant pattern of autocorrelation. I also test the residuals for each region using Bartlett's (1955) periodogram test for white noise and do not reject the hypothesis that the residuals are normally distributed for any region.

[12] For example, Arango and Welte (2012) report that the typical withdrawal by Canadians was roughly $100 in 2009. Typical Interac fees are 0.75-1.50 per transaction, which implies $\kappa_j \approx 0.01$.

are almost identical across the two specifications of the trend term, which suggests that unmodelled region or year effects are unlikely to bias these estimates. In comparison with the estimates for the same age groups that are not interacted with the Easter dummy variable, there are two notable differences. First, modelling the trend process in the error term is important for estimating the correct age-group demand effect. If the similarity between the interacted and non-interacted estimates is any guide, the year dummies appear to do a better job of controlling for unmodelled trend changes than the polynomial trends (though this is not true for the 15-24 age group). This suggests that the unmodelled variation over time is more important than regional differences over time. This result implies that changes in note demands owing to unmodelled factors, such as new note issuance or counterfeiting, are not regionally different. Second, the standard errors and the significance of the coefficient estimates are different between the interacted and non-interacted demographic factors. Turning to the demand for notes from merchants, the estimated effect of retail sales is significant and positive, while the estimate for the housing sector is negative. Both are significant at the 5% level or better. For the five-dollar bill, the data suggest that net withdrawal demand is driven by merchants as proxied by retail sales.

Interestingly, the data for the twenty-dollar net withdrawals are quite different. There is no statistically significant demand effect from either merchants or the housing sector for twenty-dollar bills. On the demographic side, demand for twenty-dollar notes is driven by increases in the 15-24 age group, while increases in the 25-54 age group lower net withdrawals. There is no statistically significant effect for the 55 plus age group. Again, the results suggest that the non-interacted results are more similar for the annual dummy specification of the trend.

The picture for the overall demand for currency as measured by the total dollar value of withdrawals appears to be a combination of the demand responses for the five- and twenty-dollar bills. Increases in the 15-24 age group lead to increases in total net withdrawals, while increases in the 25-54 and 55 plus age groups lead to decreases in total net withdrawals. These effects are significant at least at the 5% level for both specifications of the trends. Merchant demand as measured by retail sales is also positive and statistically significant, which implies that increasing retail sales volumes lead to higher demand for net withdrawals. There is no significant effect for housing. Again, the results compared to the non-interacted terms are most similar for the specification with annual dummies, although the apparent statistical significance of the estimates is smaller. For example,

merchant demand as proxied by retail sales is not statistically significantly different from zero when non-interacted with the Easter dummy.

The estimates suggest that cash demand is relatively higher for the 15-24 age group and that demand for cash falls as the population ages. There is also evidence of a strong merchant effect on the demand for cash in the five-dollar and the total dollars demand for net withdrawals. This suggests that the composition of demand for merchants is not homogeneous across denominations.[13] Moreover, the results do not necessarily imply that cash is used as a payment method at a point-of-sale, although the correlations between retail sales and total dollars and the five dollars are suggestive evidence. The results do suggest that cash withdrawals by financial institutions from the BNDS depend on the demographic structure. One interpretation is that the demand for currency rises as the population aged 15-24 rises because this age group is disproportionately likely to be paid using cash. Alternatively, this age group may frequent merchants who are less likely to accept non-cash methods of payment. Or, the 15-24 age group may be proportionately more likely to purchase low-value items and, by logical extension to the results of Arango, Huynh and Sabetti (2011), be more likely to choose to hold cash. More recent diary studies, such as the Bank of Canada's 2013-14 Methods-of-Payment Survey, currently in the field, may help to shed light on these possible interpretations.

In all specifications, the model estimates suggest that including separate Easter fixed effects by province is appropriate, since the joint significance of the Easter dummies is extremely high. In general, Easter appears to decrease profits for financial institutions from bank note withdrawals (the positive coefficient estimate implies that the underlying profit effect is negative, because in the model specification profits enter negatively in equation (8)). This would appear to be consistent with the implicit modelling assumption that bank profits are related to the number of opportunities to smooth revenues.

The model specification is admittedly parsimonious and so I consider including proxies for the fixed costs of financial intermediaries' networks. I include two additional regressors: the number of automated banking machines (ABMs) in each region by year and the number of financial intermediaries who have any withdrawals in the region by month and year. Theoretically, one would expect

[13]Some caution is warranted for these conclusions, because the estimates are strictly valid only for months with Easter. If currency demand by age groups and merchants is different on Easter holidays than during other periods, then the estimates cannot be generalized. This would, however, require that age groups behave differently in more than simply a level effect, because of the inclusion of specific-region Easter dummies.

ABMs to be positively related to profits to the extent that they replace costly branch networks. The number of financial intermediaries might be expected to be related to profits via competition. Neither regressor appears to significantly affect the estimated demands reported in Table 1 or the conclusions drawn above.[14]

In the same vein, one might think that the real money demand by individuals and merchants may have changed over the period of study. Indeed, Interac, the company that operates the largest ATM network and the main debit card network in Canada, reports that debit card usage at the point-of-sale surpassed cash in 2000.[15] To assess this conjecture, I introduce a dummy variable for the years after 2000 and interact this dummy with the demographic variables and the Easter interactions. I find no evidence of coefficient instability, since none of the post-2000 interaction terms are significantly different from zero or from the original estimate.

Finally, one might be concerned that the identification rests too heavily on a comparison with dissimilar months and that the Easter effect confounds a monthly response that is not adequately captured by the monthly dummies. I therefore re-run the regressions using only the months of March and April. This reduces the sample size to 322, but the estimates do not qualitatively challenge the conclusions described above. The point estimates are in some cases lower, but in no case do the estimates change sign. Some estimates become marginally significant (at only the 10% level), in particular the estimates for the over 55 age group and merchants as proxied by retail sales for the total dollar value of withdrawals. But, in general, the results are remarkably robust to the sample size restriction.

3.3 Withdrawals versus Deposits

The baseline results used net currency withdrawals as the dependent variable. This implicitly imposed a set of symmetry restrictions on the estimated profit function parameters. These symmetry restrictions require that the effect on financial institution profits of a withdrawal be the negative of the effect of a deposit. As an example, it imposes the restriction that reducing withdrawals by an amount w has the same effect on profits as a deposit of an amount w. Given that fees charged by financial institutions can be transactions based, it is not clear that this restriction is warranted. Nor is this restriction necessary to impose, since the data set has both withdrawal and deposit

[14] These results are available upon request.

[15] See http://www.interac.ca/index.php/en/interac-about/about-us, doi 03.03.14.

data.

A financial institution that receives deposits is free to invest these deposits in interest-bearing assets, or to deposit them with the Bank of Canada. Unlike withdrawals, deposits can earn revenue for financial institutions. Letting $\tilde{M}$ represent deposits, one can rewrite the profit function of a financial institution to account for profits resulting from deposits:

$$\Pi_t = n_{f,t}\tilde{\kappa_f}\tilde{M}^d_{f,t} + \sum_{i \in D} n_{i,t}\tilde{\kappa}_i\tilde{M}^d_{i,t} + \tilde{M}^s_t(\frac{1+I_t}{1+\pi_t} - 1). \tag{10}$$

Thus,

$$\tilde{M}^s_t(\frac{I_t - \pi_t}{1+\pi}) = \Pi_t - n_{f,t}\tilde{\kappa_f}\tilde{M}^d_{f,t} - \sum_{i \in D} n_{i,t}\tilde{\kappa}_i\tilde{M}^d_{i,t}. \tag{11}$$

One issue is the interpretation of the coefficients for the estimated demands by merchants and demographic groups. I assume that $\tilde{\kappa_f}, \tilde{\kappa}_i \geq 0$, which is equivalent to assuming that financial institutions do not compensate depositors for deposit transactions. Given this assumption, the estimated coefficients from the deposit analogue of equation (8) are the negatives of the demand for deposits by merchants and demographic groups.

Table 2 reports the estimates for gross withdrawals for the five-, twenty- and total dollar denominations using the specifications of the annual trend as described above. The general pattern of the estimates is very similar to that of the net withdrawals reported in Table 1. The demand for gross withdrawals is typically positive for the 15-24 age group and for merchants as proxied by retail sales. The demand for gross withdrawals falls as the demographic age groups 25-54 and over 55 age groups increase. There is also some evidence of a decrease in demand as the value of housing production increases. In terms of individual denominations, gross withdrawals for the five-dollar note appear to be driven by merchants. One interesting difference between the net and gross withdrawal estimates is for the twenty-dollar note. In the regressions using net withdrawals there was no evidence of statistically significant merchant demand. However, this is not true for the gross withdrawal regressions. Demand for the twenty-dollar notes is driven both by the 15-24 age group and merchants as proxied by retail sales.

Comparing the demographic and merchant variables interacted with the Easter dummy with the estimates for the non-interacted variables, there is a significant difference in the results for

both specifications of the trend. Very few of the non-interacted variables appear to be statistically significant, which suggests that endogeneity biases may be a significant concern for money-demand regressions similar to those specified here.

Turning to the estimates for gross deposits, Table 3, the estimates are largely the mirror image of those reported for gross withdrawals (recall that the estimates are the negative of the deposit demand). This result in and of itself is interesting, since it implies that currency flows may be stable within demographic groups. For example, the estimates for gross deposits suggest that deposits decrease as the 15-24 age group increases and that deposits increase as the 25-54 and over 55 age groups increase. The estimates for merchant withdrawals and deposits also reveal the lack of significance for this group for the net withdrawal estimates. The estimates for twenty-dollar bill withdrawals and deposits are nearly identical in magnitude, which suggests that merchants (as proxied by retail sales) withdraw and deposit roughly similar amounts of these bills (as long as the transaction fees are roughly similar). Again, caution is warranted for this conclusion, because the estimates are strictly valid only for Easter months.

Although a direct comparison of the gross withdrawal and deposit estimates with the net withdrawal estimates is not possible, because of the unknown transaction fees, the estimates are consistent insomuch as the gross withdrawal minus gross deposit estimates are of the same sign as the net withdrawal estimates. Interestingly, if the transactions fees are not too different, the estimates suggest that the 15-24 age group and merchants (as proxied by retail sales) are net withdrawers of currency. The 25-54 and over 55 age groups would then be net depositors of currency.

3.4 Employment

The estimates for the net withdrawal and gross withdrawal and deposit present a picture of the demographic demand for currency. These estimates imply that the real demand for currency is identical within these subpopulations. One obvious possible difference is that not everyone is employed within these age groups. A permanent income hypothesis claim might suggest that this observation is relatively unimportant because individual consumptions should be based on permanent income. However, it is well-known that such claims are, in general, not robust to credit market incompleteness, which suggests some scope for demand differences between the employed and unemployed. Ultimately, any similarity or difference is an empirical question.

To address possible differences between employed and unemployed individuals, I use the Labour Force Survey to calculate non-seasonally adjusted employed 15-24, 25-54 and 55 plus age groups and include these separate demographic groups as additional covariates in equation (8). The dependent variable in these regressions is gross withdrawals, because of the differences between the estimated net and gross demands for the twenty-dollar bill noted above. In Table 4, I report the estimates for each demographic group separately and a test of the equality of the estimated coefficients. In no case are the estimated coefficients statistically significant at conventional levels of significance when the age groups are subdivided in this way. More importantly, in no case are the estimated differences between the employed and unemployed age groups statistically significant. These conclusions are true for all three denominations and both specifications of the trend term. Thus it does not appear that employment status is a relevant factor for currency demand by individuals. As a consequence, swings in currency demand appear to only reflect seasonal patterns in employment and consumption, and do not reflect demand for currency stemming from cyclical patterns in employment (and, perhaps, by extension, GDP).

3.5 Men and Women

Another possibility is that currency demand is driven by differences in the adoption of new payment technologies by subpopulations, either because of preferences or because of labour market differences that propogate as currency demand. For example, it may be that a particular subpopulation that is more likely to be employed in a high-technology sector might be relatively less likely to demand cash. Although the data do not permit a detailed examination of this hypothesis, one simple exercise is feasible: examining men and women separately by age group.

I use the Labour Force Survey to calculate non-seasonally adjusted 15-24, 25-54 and 55 plus age groups by gender and include these separate demographic groups as the demographic covariates in equation (8). Again, the dependent variable in these regressions is gross withdrawals, because of the differences between the estimated net and gross demands noted above. The results are reported in Table 5 and indicate some evidence of gender differences in currency demand for the 15-24 age group. Increases in the population of men aged 15-24 appear to decrease the demand for twenty-dollar notes and for the total value of withdrawals. In contrast, increases in the population of women aged 15-24 appear to increase the demand for twenty-dollar notes and for the total value

of withdrawals. These differences are statistically significant at the 5% level of significance. There does not appear to be any significant difference between the currency demands of men and women in the older age groups. Although it is interesting to conjecture reasons for the apparent difference in currency demand between young men and young women, the data available do not permit a causal investigation. The evidence does suggest that studies using microdata may wish to investigate the reasons for the apparent difference in currency demand between young men and young women.

3.6 Large Denominations

The analysis thus far has focused on the five- and twenty-dollar notes (and the total dollar value), since these are the most common notes in circulation. The results indicate that the demand for bank notes is primarily driven by merchants (as proxied by retail sales) and the 15-24 age group. One may rightly wonder whether this pattern of demand holds for other notes in circulation. There are a number of differences in the usage of each denomination. For example, large-value notes are more likely to be saved (stored), since higher denominations reduce the quantity of notes necessary for any dollar value of savings. There is also some suspicion that underground economic activity may prefer large-denomination notes for similar reasons. Another example is that smaller-value notes are often used by merchants in order to make change for a transaction, and/or some merchants do not accept large-value denominations because of the possible difficulty in making change. It may be, therefore, that the pattern of note demand observed for the five- and twenty-dollar denominations does not extend to the fifty- and one-hundred-dollar denominations (one hundred is the highest-value note currently issued by the Bank of Canada).

Table 6 reports estimates of the withdrawal and deposit demand for the fifty- and one-hundred-dollar notes using the year dummy specification of the regression equation (equation (8)). The results are consistent with those of the five- and twenty-dollar notes, with the exception that the 15-24 age group is not a significant factor for the withdrawal of one-hundred-dollar notes.[16] Generally, the results suggest that merchants are a significant source of demand for withdrawals of the fifty- and one-hundred-dollar notes and that increases in the age groups 25-54 and 55 plus lower the withdrawal demand for these notes. Similarly, increases in the 25-54 and the 55 plus age

[16] I do not provide estimates for the employment and gender differences because the general pattern of demands is similar to those of the twenty-dollar and total value notes reported. The significance of the estimated demands is, however, in some cases, marginal. These results are available upon request.

groups increase the deposits of the fifty- and one-hundred-dollar bills. The 15-25 age group is also a significant source of deposits for the one-hundred-dollar bill, which suggests that they receive these notes as part of their interactions with the economy. That merchants are a significant source of demand for withdrawals of the fifty- and one-hundred-dollar notes is somewhat surprising, since these notes are not particularly useful for making change for transactions. It could be that the proxy for merchants, retail sales, confounds a price-level effect and that higher volumes of retail sales are indicative of higher-value transactions, rather than greater numbers of merchants. An alternative hypothesis, and one that might be consistent with the evidence for the 15-24 age group, is that merchants withdraw high-denomination notes to pay their employees (or suppliers), in which case high-denomination notes flow from financial institutions to merchants, from merchants to (15-24) employees and then return to the financial institution.

3.7 Calendar Effects

The central hypothesis in this paper is that exogenous changes in the timing of Easter provide variations in bank note demand by financial institutions that are independent of the covariates examined. To assess the robustness of the results to the mechanism of exogenous variation in bank note demand, I consider a second possible independent shift in the availability of the BNDS for financial institutions: variation in the number of working days per month. This channel is, in some respects, quite different than using variation in the timing of Easter, insomuch as the differences in the number of working days may imply differences in the days of the week. Whereas Good Friday is always a Friday, and so a financial institution is forecasting demand for an otherwise-identical three-day weekend, an additional (or lesser) working day can be any weekday from Monday to Friday. Thus, the identification implicitly imposes that forecasting performance for bank note demand by financial intermediaries is identical and independently distributed across days. Nevertheless, examining working-day variation is a useful robustness exercise for two reasons. First, the number of such changes is large over the sample (only 40% of the sample has the median number of working days). Second, if the estimates produce remarkably different results from the Easter experiment, then this may cast doubt on the exogeneity of the shifting timing of Easter.

For each month, I calculate the median number of working days and then construct a variable that is equal to the difference from the median for each month in the sample. To assess the

robustness of the Easter effects, I restrict the sample to exclude working-day changes in months in which Easter changes from April to March. Thus, the sample construction omits the data used to estimate the Easter effects, and so the estimates do not simply reflect the Easter effect.

I present the results for the five-, twenty-dollar and total value withdrawals and deposits in Table 7 for the 15-24, 25-54 and 55 plus age groups. The estimates are qualitatively very similar to the estimates reported in Tables 2 and 3. In general, increases in the younger cohort 15-24 increase the demand for bank notes, and increases in the cohorts 25-54 and 55 plus decrease the demand for bank notes. Retail sales are positively related to bank note demand. One qualitative difference is that the housing variable is negatively and significantly related to the demand for bank notes by financial institutions for the twenty-dollar, and total value of, withdrawals and deposits. This latter finding may reflect unmeasured economic activity as proxied by housing, or it may reflect a wealth effect from the purchase of new housing in the presence of incomplete markets. The results reported here cannot differentiate between either interpretation.

In general, the estimates using variations in the number of working days per month are qualitatively similar to those using the shifting timing of Easter.

3.8 The Patterns of Note Demand

The estimates presented in this paper can be used to illustrate the influence of demographic change and merchant demand for notes over time. I use the estimates reported in Table 1 for the age groups and retail sales interacted with the Easter dummy and compute the impact of demographic change and increases in retail sales for the evolution of bank note demands.[17] I then normalize so that the initial values for each region are equal to 1. The results are reported in Figures 2 and 3.

Figure 2 illustrates that demographic changes have contributed to a decline in the overall demand for currency during the period of study, 1990-2013. There are noticeable differences across the regions studied. In Alberta (AB), the demographic effect for currency demand has fallen by roughly 50 per cent and appears to have accelerated after roughly 2005. At the other end of the spectrum, the demographic effect for currency demand has fallen by roughly 17 per cent for Saskatchewan (SK).

Turning to retail sales, Figure 3 shows that firm effects on the demand for currency have been

[17] This exercise implicitly assumes that the Easter estimates are representative of typically daily demands and that the estimated effects are similar across provinces.

Figure 2: Demographic Net Effect for Total Bank Note Demand, 1990-2013

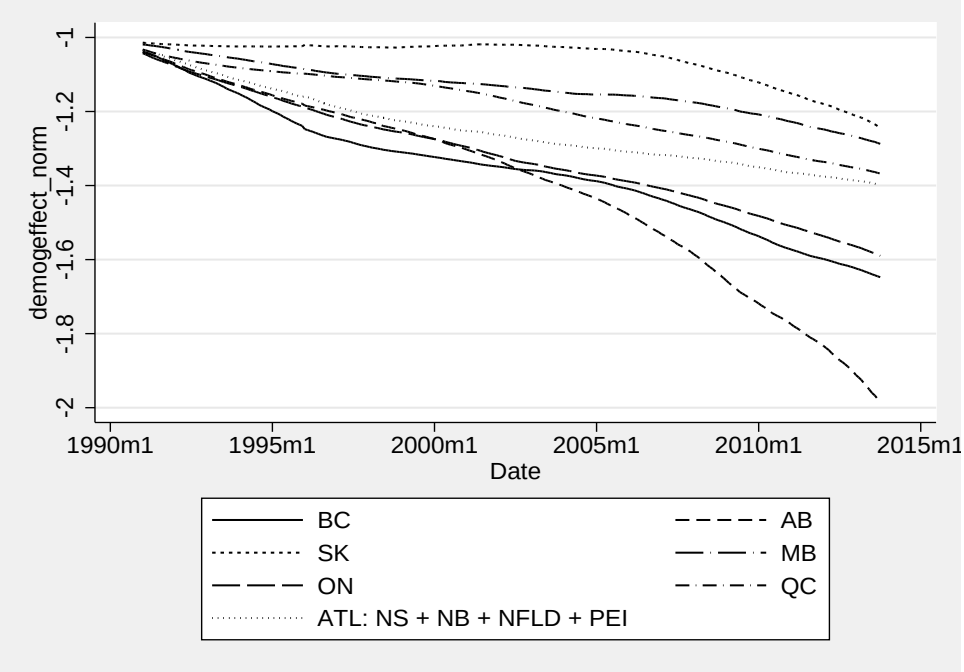
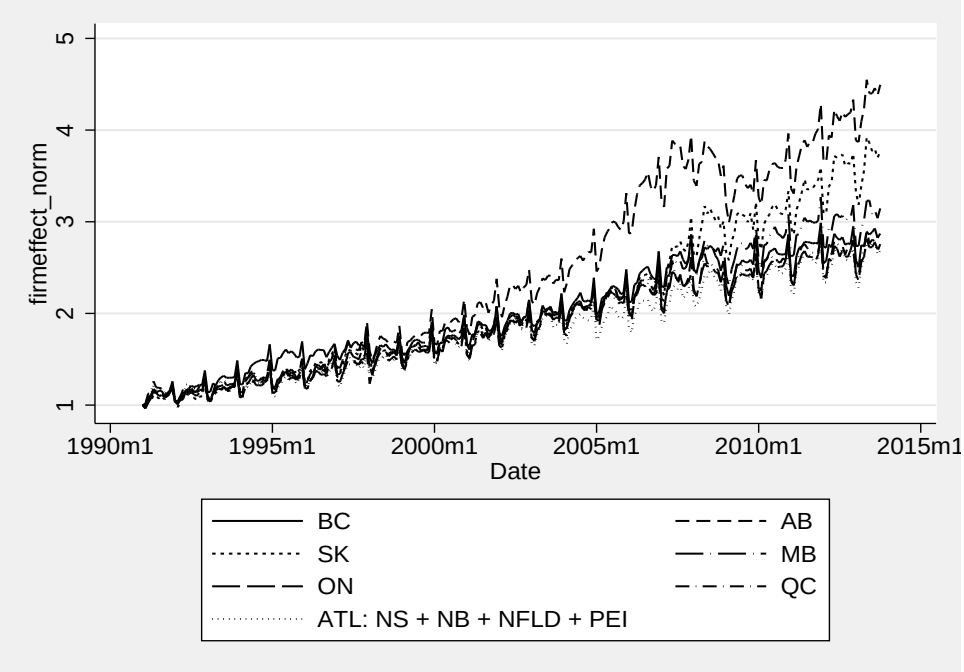


Figure 3: Firm Net Effect for Total Bank Note Demand, 1990-2013



rising over the period of study. The cumulative growth in the demand for currency by firms has risen most sharply in Alberta, roughly by a factor of 4.5, while the majority of the remaining

provinces exhibit cumulative growth closer to a factor of 3. The results for Alberta are interesting to consider since demographic factors are the most pronounced, and negative, for this province. One possibility is that the demand for currency in Alberta is driven by firm both for transactional and payroll purposes, and that individuals are less likely to withdraw cash from their financial institutions in this province since they receive currency from their employers.

4 Conclusion

This paper has used the timing of Easter in the Gregorian calendar as a source of exogenous variation to investigate the demand for currency by demographic age groups and by merchants. The evidence reported in this paper suggests differences across denominations in the demand for currency by the different demographic age groups. Younger age groups (in particular, younger women) and merchants appear to be the main drivers of the demand for currency. Increases in the demographic age groups 25-54 and 55 plus tend to lower the demand for currency withdrawals by financial institutions. There is no evidence of changes in demand for currency stemming from labour market conditions.

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5 Appendix

Figure 4: 15-24 Age Group by Region (millions), 1990-2013

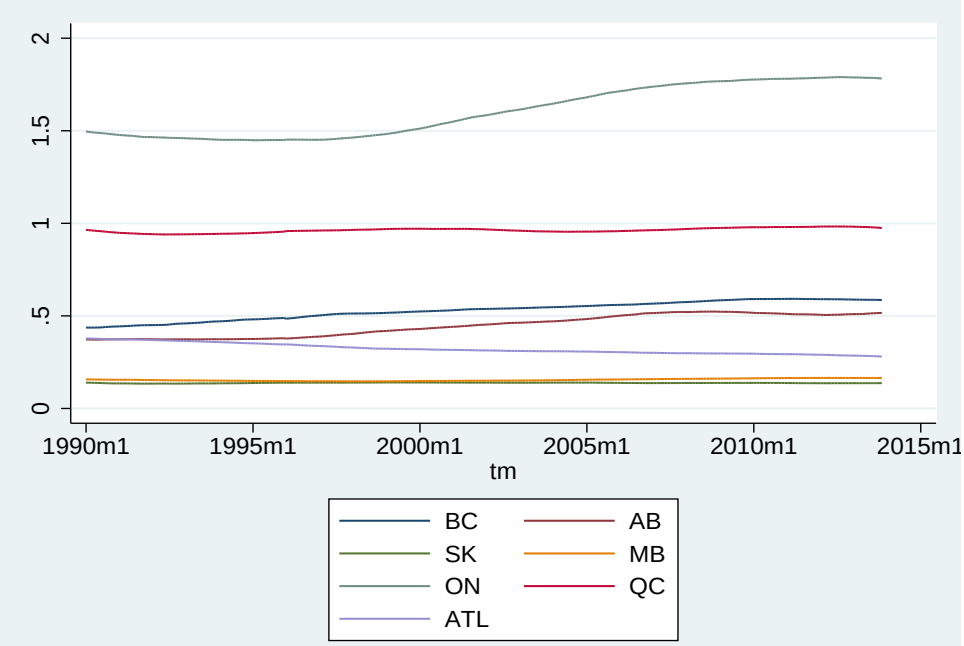

Figure 5: 25-54 Age Group by Region (millions), 1990-2013

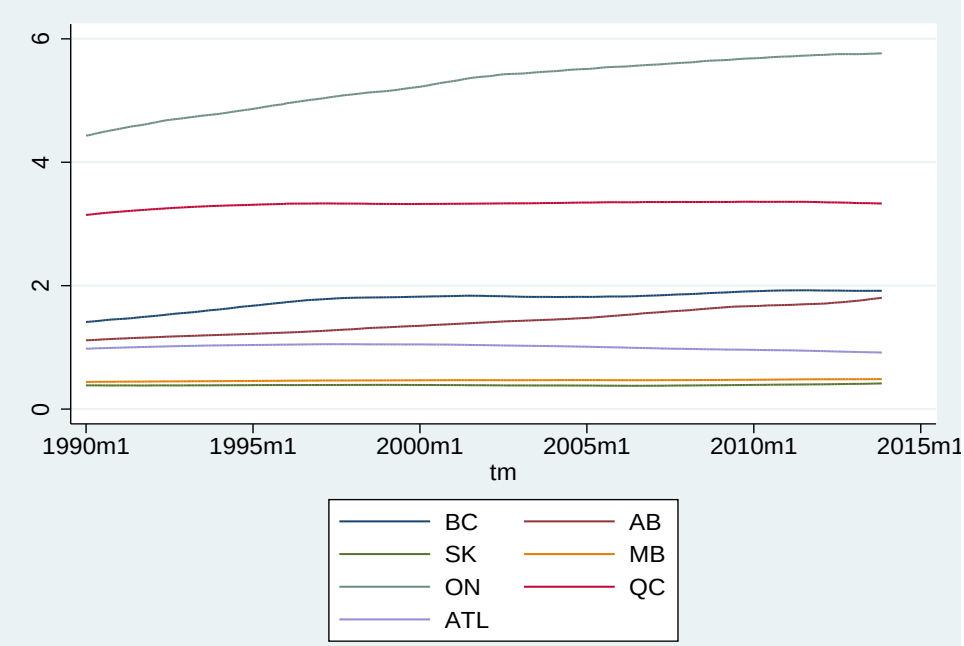

Figure 6: 55 Plus Age Group by Region (millions), 1990-2013

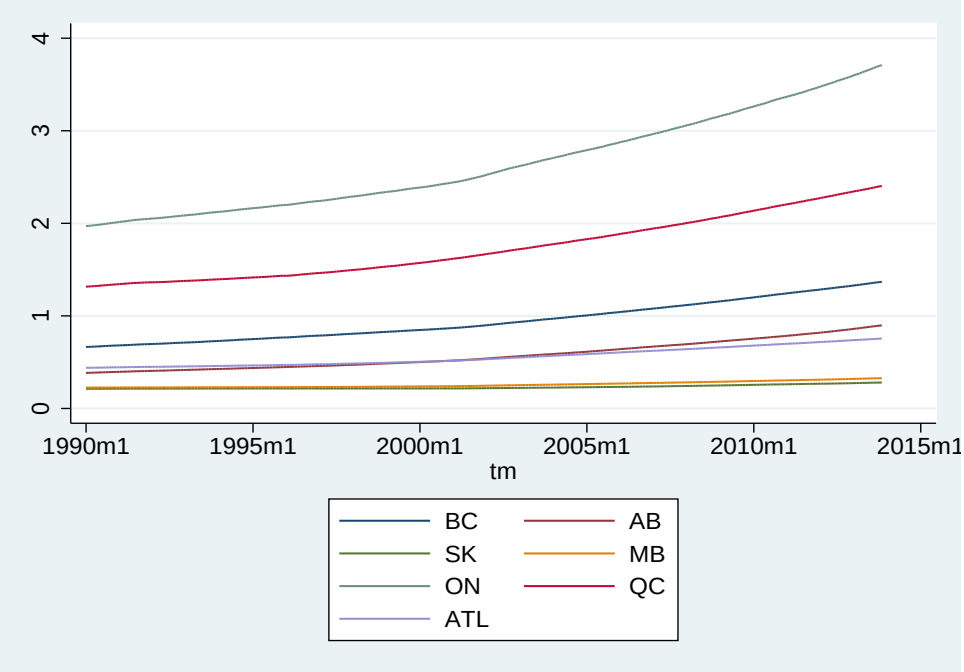

Figure 7: Retail Sales by Region (billions), 1990-2013

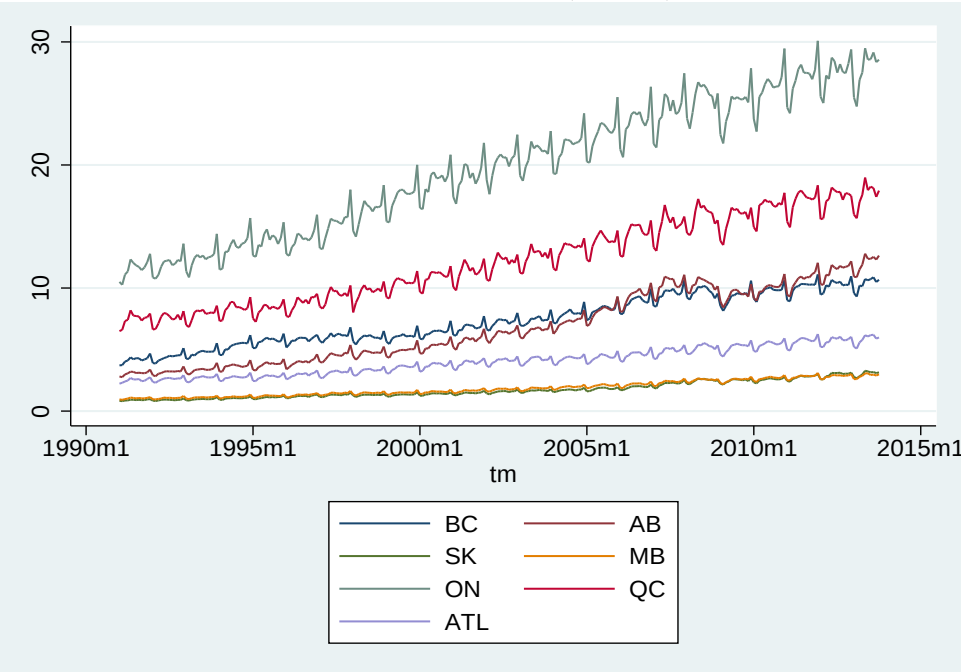

Figure 8: Housing Completions by Region (thousands), 1990-2013

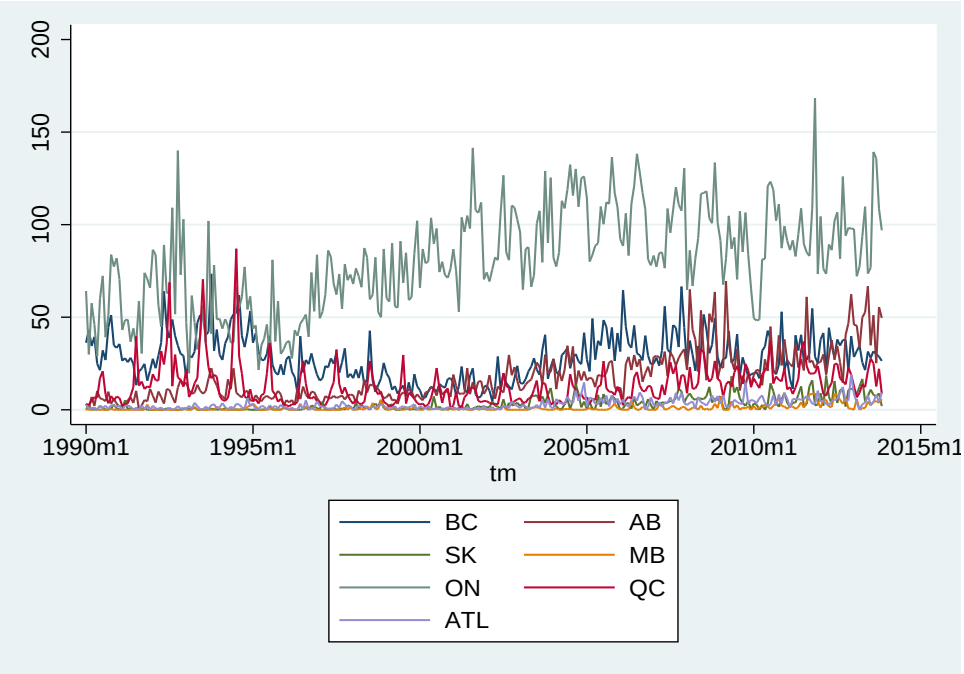

Table 1: Net Withdrawals

	5 Dollars				20 Dollars				Total Dollars			
	Coeff	Std Err	Coeff	Std Err	Coeff	Std Err	Coeff	Std Err	Coeff	Std Err	Coeff	Std Err
Retail Sales	0.003*	0.001	0.0016	0.0009	0.0152	0.0072	0.0096	0.0051	0.6221	0.2592	0.3762	0.1959
Housing Completions	<0.0001	<0.0001	0.0001	<0.0001	<0.0001	0.0001	0.0001	0.0001	0.0024	0.0038	0.0049	0.0034
15-24 age group	0.07	0.06	0.0646*	0.0215	-0.2121	0.5299	0.1782*	0.0634	-0.3627	13.5906	6.6865*	2.5169
25-54 age group	-0.07	0.04	-0.0291*	0.0107	-0.0368	0.1702	-0.1138*	0.0453	-4.2106	4.4522	-4.2753*	1.7358
55 plus age group	-0.10	0.08	-0.0233*	0.0071	0.0720	0.4111	-0.0825*	0.0329	-1.2487	13.8682	-3.1255	1.3135
Easter	0.10*	0.03	0.0929*	0.0271	0.2559	0.1139	0.2383	0.1151	13.2440*	4.2810	12.5319*	4.2105
Easter – BC	-0.06**	0.02	-0.0598*	0.0181	-0.1661	0.0768	-0.1536	0.0772	-8.7192*	2.8768	-8.2113*	2.8176
Easter – AB	-0.08*	0.02	-0.0766**	0.0203	-0.1973	0.0893	-0.1817	0.0899	-10.7316*	3.5117	-10.0955*	3.4452
Easter – SK	-0.09*	0.02	-0.0843*	0.0245	-0.2374	0.1047	-0.2207	0.1058	-12.2372*	3.9101	-11.5645*	3.8419
Easter – MB	-0.09*	0.02	-0.0841*	0.0241	-0.2330	0.1029	-0.2163	0.1039	-12.0999*	3.8734	-11.4235*	3.8057
Easter – QC	-0.03*	0.01	-0.0323*	0.0109	-0.0741	0.0422	-0.0660	0.0422	-4.5573*	1.7857	-4.2310	1.7559
Easter – ATL	-0.08*	0.02	-0.0754*	0.0215	-0.2054	0.0920	-0.1903	0.0928	-10.7045*	3.4802	-10.0971*	3.4181
Easter x 15-24 age group	0.03	0.02	0.0318	0.0188	0.1721*	0.0514	0.1745*	0.0508	4.9099*	1.4171	5.0349*	1.3950
Easter x 25-54 age group	-0.03**	0.01	-0.0266**	0.0067	-0.1093*	0.0318	-0.1077*	0.0325	-3.8088**	0.8684	-3.7567**	0.8603
Easter x 55 plus age group	-0.03***	0.001	-0.0293***	0.0032	-0.0287	0.0194	-0.0223	0.0180	-3.4788*	1.1871	-3.2027*	1.1503
Easter x Retail Sales	0.004***	0.001	0.0042***	0.0006	0.0059	0.0029	0.0050	0.0029	0.4676*	0.1603	0.4291*	0.1550
Easter x Housing	-0.0002*	0.0001	-0.0002*	0.0001	<0.0001	0.0001	0.0001	0.0001	-0.0134	0.0097	-0.0110	0.0099
Month Dummy	Yes		Yes		Yes		Yes		Yes		Yes	
Province Dummy	Yes		Yes		Yes		Yes		Yes		Yes	
Time	PT		YD		PT		YD		PT		YD	
Easter F	495.72***		3 $\hat{E5}$***		196.21***		133.03***		35.2***		89.74***	
Nobs	1918		1918		1918		1918		1918		1918	

Notes: Asterisks represent the significance of the results: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. PT refers to a cubic polynomial trend by region. YD refers to annual dummy variables. Full estimation results are available upon request.

Table 2: Gross Withdrawals

	Withdrawals											
	5 Dollars				20 Dollars				Total Dollars			
	Coeff	Std Err	Coeff	Std Err	Coeff	Std Err	Coeff	Std Err	Coeff	Std Err	Coeff	Std Err
Retail Sales	0.0041*	0.0013	0.0021	0.0012	0.0238**	0.0051	0.0086	0.0054	0.8623**	0.1917	0.3517	0.2010
Housing Completions	<0.0001	<0.0001	-0.0001	0.0001	0.0002	0.0001	0.0001	0.0001	0.0077	0.0036	0.0058	0.0048
15-24 age group	-0.1306	0.0817	0.1122*	0.0371	0.0488	0.4294	0.2685	0.1294	7.5915	19.3842	10.0146	4.4983
25-54 age group	-0.0424	0.0652	-0.0719*	0.0265	-0.2223	0.2250	-0.1226	0.0811	-9.4093	8.8708	-5.0924	2.9233
55 plus age group	0.2087	0.1194	-0.0468**	0.0119	-0.2203	0.2790	-0.1638**	0.0283	-5.2459	8.8621	-5.6920**	1.0262
Easter	0.0427	0.0458	0.0551	0.0488	0.6112**	0.1118	0.6161**	0.1202	23.4901**	4.8296	23.5031**	5.0616
Easter – BC	-0.0263	0.0304	-0.0341	0.0323	-0.3960**	0.0700	-0.3962**	0.0754	-15.2533**	3.1042	-15.1638**	3.2605
Easter – AB	-0.0458	0.0357	-0.0559	0.0379	-0.4963**	0.0842	-0.4968**	0.0907	-19.2915**	3.6412	-19.1925**	3.8385
Easter – SK	-0.0378	0.0417	-0.0491	0.0444	-0.5625**	0.0983	-0.5662**	0.1056	-21.6292**	4.2979	-21.6096**	4.5047
Easter – MB	-0.0402	0.0408	-0.0512	0.0433	-0.5565**	0.0946	-0.5586**	0.1015	-21.4474**	4.1772	-21.3822**	4.3775
Easter – QC	-0.0105	0.0178	-0.0140	0.0182	-0.2195***	0.0284	-0.2117***	0.0278	-8.4800**	1.4987	-8.1999**	1.5472
Easter – ATL	-0.0356	0.0362	-0.0452	0.0383	-0.4934**	0.0828	-0.4939**	0.0885	-19.0072**	3.6834	-18.9105**	3.8547
Easter x 15-24 age group	0.0736	0.0477	0.0775	0.0481	0.3436*	0.1056	0.3697*	0.1140	12.1922*	3.6419	12.9573*	3.8733
Easter x 25-54 age group	-0.0303	0.0173	-0.0338	0.0189	-0.2248**	0.0516	-0.2370**	0.0557	-7.8934**	1.8207	-8.2315**	1.9150
Easter x 55 plus age group	-0.0433**	0.0081	-0.0470**	0.0083	-0.1619**	0.0427	-0.1576*	0.0438	-7.3522***	1.0182	-7.1893**	1.1074
Easter x Retail Sales	0.0063**	0.0012	0.0067**	0.0013	0.0263***	0.0043	0.0255**	0.0044	1.0586***	0.1313	1.0282***	0.1400
Easter x Housing	-0.0003	0.0001	-0.0002	0.0002	-0.0011	0.0005	-0.0008	0.0005	-0.0458*	0.0130	-0.0386*	0.0132
Month Dummy	Yes											
Province Dummy	Yes											
Time	PT		YD		PT		YD		PT		YD	
Easter F	181.49		150.15		60.14		93.13		296.12		283.67	
Nobs	1918		1918		1918		1918		1918		1918	

Notes: Asterisks represent the significance of the results: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. PT refers to a cubic polynomial trend by region. YD refers to annual dummy variables. Full estimation results are available upon request.

Table 3: Gross Deposits

	Deposits											
	5 Dollars				20 Dollars				Total Dollars			
	Coeff	Std Err	Coeff	Std Err	Coeff	Std Err	Coeff	Std Err	Coeff	Std Err	Coeff	Std Err
Retail Sales	0.0007	0.0004	0.0005	0.0014	0.0086	0.0069	-0.0011	0.0028	0.2401	0.1784	-0.0245	0.0766
Housing Completions	<0.0001	<0.0001	-0.0001*	< 0.0001	0.0002	0.0001	<0.0001	0.0001	0.0053	0.0038	0.0009	0.0044
15-24 age group	-0.1998	0.0948	0.0476	0.0218	0.2609	0.7665	0.0903	0.0702	7.9542	23.4074	3.3281	2.1853
25-54 age group	0.0233	0.0425	-0.0428*	0.0163	-0.1855	0.3250	-0.0088	0.0367	-5.1986	10.1575	-0.8171	1.1927
55 plus age group	0.3064**	0.0515	-0.0235	0.0176	-0.2923	0.1520	-0.0813*	0.0242	-3.9972	6.2756	-2.5665**	0.6538
Easter	-0.0526	0.0228	-0.0378	0.0243	0.3553*	0.1104	0.3778*	0.1178	10.2460**	1.8922	10.9712**	2.1430
Easter – BC	0.0352	0.0153	0.0257	0.0162	-0.2298*	0.0734	-0.2426*	0.0766	-6.5341**	1.2011	-6.9526**	1.3312
Easter – AB	0.0332	0.0181	0.0207	0.0193	-0.2990*	0.0950	-0.3151*	0.0998	-8.5599**	1.6263	-9.0969**	1.7823
Easter – SK	0.0488	0.0209	0.0351	0.0224	-0.3252*	0.1018	-0.3454*	0.1075	-9.3920**	1.7052	-10.0451**	1.9032
Easter – MB	0.0463	0.0205	0.0329	0.0218	-0.3235*	0.1001	-0.3423*	0.1052	-9.3474**	1.6424	-9.9587**	1.8236
Easter – QC	0.0231	0.0101	0.0184	0.0112	-0.1454*	0.0424	-0.1457*	0.0412	-3.9228***	0.5602	-3.9689***	0.5642
Easter – ATL	0.0419	0.0182	0.0302	0.0193	-0.2880*	0.0893	-0.3036*	0.0934	-8.3028**	1.4234	-8.8134**	1.5765
Easter x 15-24 age group	0.0423	0.0371	0.0457	0.0374	0.1715	0.0720	0.1952	0.0840	7.2824*	2.2443	7.9224**	2.5191
Easter x 25-54 age group	-0.0037	0.0118	-0.0072	0.0130	-0.1155*	0.0377	-0.1293*	0.0439	-4.0846**	1.0442	-4.4748**	1.1890
Easter x 55 plus age group	-0.0125	0.0076	-0.0177	0.0080	-0.1332*	0.0496	-0.1353*	0.0519	-3.8734*	1.2912	-3.9866*	1.3297
Easter x Retail Sales	0.0019	0.0008	0.0025*	0.0008	0.0204*	0.0054	0.0204*	0.0056	0.5910**	0.1151	0.5990**	0.1190
Easter x Housing	-0.0001	0.0001	-0.0001	0.0001	-0.0011	0.0005	-0.0009	0.0004	-0.0324*	0.0128	-0.0276	0.0131
Month Dummy	Yes											
Province Dummy	Yes											
Time	PT		YD		PT		YD		PT		YD	
Easter F	790.27		1229.46		60.14		19.02		139.25		27.1	
Nobs	1918		1918		1918		1918		1918		1918	

Notes: Asterisks represent the significance of the results: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. PT refers to a cubic polynomial trend by region. YD refers to annual dummy variables. Full estimation results are available upon request.

Table 4: Employment Status and Withdrawal Demand

	5 Dollar				20 Dollar				Total Dollar			
Easter Interaction with	Coeff	Std Err	Coeff	Std Err	Coeff	Std Err	Coeff	Std Err	Coeff	Std Err	Coeff	Std Err
15-24 Population	-0.116	0.076	-0.180	0.117	-0.847	0.738	-0.986	0.723	-27.316	26.129	-32.000	26.115
15-24 Employed	0.182	0.135	0.250	0.172	1.530	0.685	1.722	0.755	47.891	24.543	53.824	26.349
25-54 Population	0.001	0.039	0.010	0.047	-0.255	0.413	-0.260	0.478	-7.553	11.661	-7.334	13.576
25-54 Employed	-0.073	0.042	-0.105	0.069	-0.557	0.348	-0.630	0.360	-17.958	11.944	-20.351	12.536
55 Plus Population	-0.051	0.078	-0.093	0.086	-1.116	0.537	-1.263	0.666	-31.286	14.321	-35.420	17.851
55 Plus Employed	-0.043	0.028	-0.043	0.030	0.109	0.259	0.135	0.282	-0.563	7.928	0.074	8.550
Tests of Coefficient Equality Between Employed and Population												
15-24: Population - Employed	0.299	0.204	0.430	0.282	2.377	1.322	2.708	1.349	75.206	48.349	85.824	49.524
25-54: Population - Employed	-0.074	0.052	-0.115	0.096	-0.302	0.696	-0.371	0.757	-10.405	21.155	-13.018	23.241
55 Plus: Population - Employed	0.008	0.096	0.050	0.103	1.225	0.757	1.397	0.909	30.723	19.957	35.494	24.226
Month Dummy	Yes		Yes		Yes		Yes		Yes		Yes	
Province Dummy	Yes		Yes		Yes		Yes		Yes		Yes	
Time	PT		YD		PT		YD		PT		YD	
Nobs	1918		1918		1918		1918		1918		1918	

Notes: Asterisks represent the significance of the results: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. PT refers to a cubic polynomial trend by region. YD refers to annual dummy variables. Full estimation results are available upon request.

Table 5: Gender and Withdrawal Demand

	5 Dollar				20 Dollar				Total Dollar			
Easter Interaction with	Coeff	Std Err	Coeff	Std Err	Coeff	Std Err	Coeff	Std Err	Coeff	Std Err	Coeff	Std Err
Men 15-24	-0.737	0.430	-0.781	0.447	-4.729*	1.411	-4.534*	1.395	-184.780*	65.941	-178.45*	66.762
Men 25-54	-0.209	0.114	-0.187	0.101	-0.747	0.604	-0.794	0.603	-32.593	24.642	-34.104	24.748
Men 55 plus	-0.493	0.380	-0.406	0.362	-2.864	1.982	-2.848	1.961	-85.422	75.946	-84.889	74.737
Women 15-24	0.895	0.464	0.942	0.481	5.442*	1.509	5.270*	1.452	213.926*	63.971	208.365*	64.179
Women 25-54	0.111	0.086	0.103	0.082	0.157	0.535	0.185	0.526	12.289	21.693	13.169	21.563
Women 55 plus	0.345	0.339	0.271	0.328	2.272	1.877	2.256	1.849	61.260	70.485	60.765	69.061
Tests of Coefficient Equality Between Men and Women												
15-24: Men - Women	-1.723	0.928	-1.632	0.893	-10.170*	2.871	-9.805*	2.800	-398.71*	128.840	-386.82*	129.998
25-54: Men - Women	-0.291	0.179	-0.320	0.196	-0.905	1.127	-0.978	1.118	-44.882	46.030	-47.273	45.997
55 plus: Men - Women	-0.677	0.690	-0.838	0.718	-5.136	3.858	-5.104	3.809	-146.682	146.391	-145.654	143.753
Month Dummy	Yes		Yes		Yes		Yes		Yes		Yes	
Province Dummy	Yes		Yes		Yes		Yes		Yes		Yes	
Time	PT		YD		PT		YD		PT		YD	
Nobs	1918		1918		1918		1918		1918		1918	

Notes: Asterisks represent the significance of the results: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. PT refers to a cubic polynomial trend by region. YD refers to annual dummy variables. Full estimation results are available upon request.

Table 6: Large Denomination Withdrawals and Deposits

	50 Dollars				100 Dollars			
	Withdrawals		Deposits		Withdrawals		Deposits	
	Coeff	Std Err	Coeff	Std Err	Coeff	Std Err	Coeff	Std Err
Retail Sales	0.0015	0.0008	0.0002	0.0002	0.0009	0.0005	-0.0001	0.0001
Housing Completions	0.0001*	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
15-24 age group	0.0293	0.0125	0.0084*	0.0032	0.0164	0.0075	0.0020	0.0022
25-54 age group	-0.0167	0.0081	-0.0029	0.0022	-0.0093	0.0052	0.0005	0.0010
55 plus age group	-0.0183*	0.0060	-0.0081**	0.0013	-0.0094*	0.0027	-0.0023*	0.0008
Easter	0.0820	0.0260*	0.0486	0.0174*	0.0626**	0.0148	0.0128*	0.0042
Easter – BC	-0.0525*	0.0171	-0.0301*	0.0114	-0.0410**	0.0098	-0.0081*	0.0028
Easter – AB	-0.0652*	0.0198	-0.0383*	0.0127	-0.0522**	0.0124	-0.0103*	0.0032
Easter – SK	-0.0756*	0.0236	-0.0448*	0.0158	-0.0576**	0.0134	-0.0117*	0.0039
Easter – MB	-0.0747*	0.0231	-0.0442*	0.0154	-0.0572**	0.0133	-0.0117*	0.0038
Easter – QC	-0.0259*	0.0086	-0.0151*	0.0057	-0.0244*	0.0070	-0.0048*	0.0018
Easter – ATL	-0.0659*	0.0205	-0.0390*	0.0137	-0.0507**	0.0120	-0.0104*	0.0034
Easter x 15-24 age group	0.0613*	0.0177	0.0449*	0.0120	0.0149	0.0091	0.0108*	0.0043
Easter x 25-54 age group	-0.0341*	0.0099	-0.0228*	0.0069	-0.0131**	0.0031	-0.0056*	0.0016
Easter x 55 plus age group	-0.0219**	0.0040	-0.0142*	0.0042	-0.0241**	0.0053	-0.0040	0.0019
Easter x Retail Sales	0.0032**	0.0006	0.0021**	0.0004	0.0028**	0.0007	0.0006*	0.0002
Easter x Housing	-0.0001**	<0.0001	-0.0001*	<0.0001	-0.0001	0.0001	<0.0001	<0.0001
Month Dummies	Yes		Yes		Yes		Yes	
Province Dummies	Yes		Yes		Yes		Yes	
Time	YD		YD		YD		YD	
Easter F	4.75E+03		2303.57		9798.12		111.2	
Nobs	1918		1918		1918		1918	

Notes: Asterisks represent the significance of the results: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. PT refers to a cubic polynomial trend by region. YD refers to annual dummy variables. Full estimation results are available upon request.

Table 7: Calendar Effect: Withdrawals and Deposits

	5 Dollars				20 Dollars				Total Value			
	Withdrawals		Deposits		Withdrawals		Deposits		Withdrawals		Deposits	
	Coeff	Std Err	Coeff	Std Err	Coeff	Std Err	Coeff	Std Err	Coeff	Std Err	Coeff	Std Err
Retail Sales	0.004*	0.001	0.001	0.001	0.017*	0.005	0.006	0.004	0.649*	0.213	0.191	0.081
Housing Completions	-0.007	0.004	-0.012*	0.004	0.000	0.015	-0.003	0.015	0.254	0.564	-0.122	0.446
15-24 Cohort	0.117*	0.037	0.046	0.022	0.291	0.131	0.108	0.070	10.998	4.612	3.868	2.174
25-54 Cohort	-0.079*	0.027	-0.044*	0.017	-0.157	0.078	-0.041	0.032	-6.358	2.964	-1.755	1.133
55 plus Cohort	-0.059***	0.010	-0.028	0.016	-0.231*	0.045	-0.136*	0.044	-8.050**	1.480	-4.228**	1.037
Working Day	0.053**	0.012	0.028*	0.011	0.153*	0.046	0.134*	0.048	4.130*	1.420	3.866*	1.088
Working Day – BC	-0.034**	0.008	-0.019*	0.007	-0.099*	0.031	-0.088*	0.032	-2.605*	0.961	-2.538*	0.734
Working Day – AB	-0.042**	0.008	-0.023*	0.008	-0.127*	0.040	-0.111*	0.040	-3.444*	1.182	-3.213*	0.934
Working Day – SK	-0.049**	0.011	-0.026*	0.010	-0.143*	0.042	-0.124*	0.043	-3.861*	1.304	-3.592*	0.980
Working Day – MB	-0.048**	0.011	-0.025*	0.010	-0.140*	0.041	-0.123*	0.043	-3.780*	1.279	-3.535*	0.969
Working Day – QC	-0.018**	0.005	-0.011*	0.004	-0.055*	0.017	-0.058*	0.018	-1.562*	0.456	-1.660**	0.434
Working Day – ATL	-0.043**	0.010	-0.023*	0.009	-0.127*	0.036	-0.112*	0.038	-3.479*	1.109	-3.245**	0.862
Working Day x 15-24 Cohort	0.017	0.008	-0.017*	0.006	0.081*	0.026	-0.004	0.051	3.032*	0.912	0.129	1.556
Working Day x 25-54 Cohort	-0.014*	0.005	0.000	0.003	-0.045***	0.005	-0.028*	0.010	-1.361***	0.188	-0.856	0.408
Working Day x 55 plus Cohort	-0.014**	0.003	-0.009*	0.003	-0.067	0.028	-0.039	0.024	-2.121*	0.756	-1.325	0.681
Working Day x Retail Sales	0.002***	0.000	0.001*	0.000	0.009*	0.003	0.008*	0.003	0.262**	0.066	0.250*	0.076
Working Day x Housing	-0.003	0.002	-0.001	0.002	-0.040*	0.012	-0.046*	0.013	-1.493*	0.422	-1.294*	0.395
Month Dummies	Yes		Yes		Yes		Yes		Yes		Yes	
Province Dummies	Yes		Yes		Yes		Yes		Yes		Yes	
Time	YD		YD		YD		YD		YD		YD	
Nobs	1876		1876		1876		1876		1876		1876	

Notes: Asterisks represent the significance of the results: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. PT refers to a cubic polynomial trend by region. YD refers to annual dummy variables. Full estimation results are available upon request.