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IMMIGRATION AND LARGE BANKNOTES

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Do immigrants have a higher demand for large-denominated banknotes than natives? This micro study examines whether banknote orders for CHF 1,000 notes are concentrated in Swiss municipalities with a high foreign-to-native ratio. The evidence for 251 Swiss municipalities finds that immigrants hoard fewer CHF 1,000 banknotes than natives. This empirical result means that immigration reduces seigniorage (per person) as measured by banknote orders. A 1% increase in the immigrant-to-native ratio is coincident with a reduction in banknote orders by CHF 4,000. This reduction is attributed to specific traits linked to immigrants.

Keywords: Immigration, Large Banknotes, Hoarding, Money Demand

1. INTRODUCTION

The inability to track banknotes in circulation complicates the estimation of regional money demand functions. This estimation hurdle is even more pronounced for the world's largest banknote, the CHF 1,000 note.[1] It is rarely used in daily transactions, yet the currency volume of CHF 22.4 billion for the CHF 1,000 note means that the average Swiss resident held at least three of them in 2007 (the Swiss population was 7.4 million). Of these residents, a large percentage are foreigners (22.1% of the Swiss resident population in 2007). Their residencies and those of natives are well known, as are the banknotes' delivery destinations. With this information, I ask: what can the traits of municipalities with a high share of immigrants, hereafter immigrant municipalities, tell us about the demand for large banknotes?

This empirical analysis investigates the impact of immigration on large banknotes across 251 Swiss municipalities. A priori, the correlation between immigration and large banknotes is unclear. A positive correlation may reflect a low level of financial participation in banking services or immigrant preferences for sending home remittances. Alternatively, a negative correlation may capture tax avoidance (Boeschoten and Fase, 1992) or particular traits (e.g., lower average

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age or lower wealth than natives) that enter a traditional model of precautionary money demand.

The study contributes to the vast literature on money demand by touching on the domains of immigration and monetary policy. It is the first to estimate a currency demand specification at the regional level. Previous studies on regional money demand have used bank deposits as a measure of narrow money.[2] I overcome this data problem for regional cash holdings by using banknote orders at the bank-branch level. A further contribution is to identify immigration's impact in money demand. A contentious issue in many micro studies on immigration and prices is the separation between demand and supply effects; see Lach (2007), Cortes (2008), and Frattini (2008). This identification issue is simplified, because banknote orders are strictly demand-oriented.

The empirical results show that large banknote hoarding is less prevalent in immigrant municipalities. The negative correlation between immigration and large banknotes is robust with respect to geographical location (e.g., rural, city size, elevation), immigrant nationality, taxes, and seasonal fluctuations. A 1% increase in the immigrant-to-native ratio is coincident with a reduction by CHF 4,000. This means that immigration reduces seigniorage per capita as measured by banknote orders. This reduction is attributed to specific traits linked to immigrants that are consistent with precautionary money demand.

The paper begins in Section 2 by presenting four hypotheses linking immigration and large banknotes. Section 3 then lays out the empirical framework together with the data. Thereafter, Section 4 presents the main results with robustness checks. Section 5 offers conclusions on the importance of immigrant traits for money demand estimation at the regional level.

2. FOUR HYPOTHESES LINKING IMMIGRATION AND LARGE BANKNOTES

Of the four hypotheses that link large banknote hoarding to immigrants, the first two—precautionary money demand and tax avoidance—predict that immigrants hold fewer large denominated banknotes than natives, whereas the third and fourth hypotheses—on remittances and lack of financial participation—predict that immigrants hold larger banknotes.[3]

The most popular hypothesis is precautionary demand for money. In the microfoundations literature developed by Miller and Orr (1966), Whalen (1966), and Frenkel and Jovanovic (1988), the real quantity of money balances demanded for transactions and precautionary purposes is a function of several factors: real income, the variance of real income, the rate of interest on an alternative asset, and a set of demographic variables. Aside from income differences between regions, immigration captures important sociodemographic traits such as age and education.[4] Mulligan and Sala-i-Martin (1996) argue that the cost of adopting financial technologies is positively related to age (opportunity costs) and negatively related

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to the level of education.[5] Adoption, or not, of new financial technologies available in a new country is a decision that confronts immigrants.

Immigrants in Switzerland reveal traits different from those of natives. First, on average, they are younger than natives. The share of immigrant workers below the age of 40 was 56% in 2006, whereas for Swiss workers it was 44%, according to the Swiss Bureau for Statistics (Bündesamt für Statistik [BfS], 2008).[6] This lower average age should yield a negative correlation between immigrant municipalities and large banknotes. Second, their average educational level is lower than that of natives. Table 1 shows the absolute numbers and their percentages for three education categories: high school certificate, apprenticeship, and university degree. A striking feature is the high percentage of immigrants with only a high school degree (32%) compared to natives (13%) in 2006.[7] The demographic trait of low immigrant education should result in low rates of adoption of new financial technologies. Thus, a positive correlation between immigrant municipalities and large banknotes is predicted.[8]

A second hypothesis about holding large banknotes is tax avoidance [see Boeschoten and Fase (1992) and Maradan (2007)]. The Swiss wealth tax is annual and is levied at the cantonal level.[9] The basis of assessment is as follows: residents pay an annual wealth tax on the value of all assets located in Switzerland. The progressive wealth tax varies slightly between cantons, with a maximum of around 1.5% levied on net assets. Individuals whose wealth is below CHF 250,000 are exempted from the tax.

Large banknote holdings are a simple means of avoiding the wealth tax and should yield a distinct seasonal pattern. Because this tax is based on the end-of-year financial position, large banknote holdings should increase before the year's end to reduce the wealth stated on financial statements. However, in the new year, large banknote holdings should fall to reap interest income. Thus at the quarterly frequency, a rise in the fourth quarter in year t and a fall in the first quarter of year $t + 1$ is expected for large banknotes.[10]

In the aggregate, the seasonal pattern of tax evasion should behave similarly to a Christmas shopping effect, but more strongly, because of the larger wealth effect. Figure 1 shows the seasonal pattern of notes in circulation for transaction purposes (i.e., CHF 10, 20, 50, and 100 notes added together) and for storage purposes (i.e., CHF 1,000 notes) from 1980:1 to 2009:12. The graph shows indirect evidence consistent with the tax evasion argument: the seasonal pattern for the CHF 1,000 note is larger than the combined Christmas effect stemming from the aggregated notes for transaction purposes.[11] The values are normalized at 1980:1. Because the CHF 1,000 note is not readily available at all ATM machines and is not accepted in all stores, the marked seasonal pattern in Figure 1 is attributed to other nonshopping domestic activities: tax evasion (i.e., CHF 1,000 notes dispersed regionally) or bank window dressing (i.e., CHF 1,000 notes concentrated in cities of major bank headquarters).[12]

The wealth tax's deduction means that the less wealthy, which includes immigrants, have a lower incentive to evade (or are not affected by) the tax. Although

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TABLE 1. Education of Swiss and immigrants (thousands)

	2006	2007	2006	2007
High school certificate	680	675	0.168	0.164
Swiss	410	408	0.128	0.128
Immigrants	270	267	0.318	0.305
Germany	3	3	0.031	0.023
France	3	4	0.067	0.082
Italy	54	52	0.332	0.318
Spain and Greece	18	15	0.337	0.309
Portugal	70	73	0.676	0.661
Serbia	71	70	0.445	0.431
Appenticeship	2198	2204	0.543	0.535
Swiss	1852	1850	0.579	0.570
Immigrants	346	354	0.407	0.404
Germany	36	38	0.348	0.333
France	16	16	0.381	0.357
Italy	83	84	0.510	0.518
Spain and Greece	25	23	0.479	0.467
Portugal	28	31	0.273	0.281
Serbia	79	82	0.494	0.507
University degree	1173	1243	0.290	0.302
Swiss	939	988	0.293	0.304
Immigrants	234	255	0.275	0.291
Germany	64	74	0.622	0.644
France	23	25	0.553	0.561
Italy	26	26	0.158	0.163
Spain and Greece	10	11	0.184	0.224
Portugal	5	6	0.051	0.058
Serbia	10	10	0.060	0.062
Total	4051	4122	1.000	1.000
Swiss	3201	3246	1.000	1.000
Immigrants	850	876	1.000	1.000
Germany	103	115	1.000	1.000
France	43	45	1.000	1.000
Italy	163	162	1.000	1.000
Spain and Greece	52	50	1.000	1.000
Portugal	103	110	1.000	1.000
Serbia	159	161	1.000	1.000

Source: Swiss Federal Statistics Office. Sake Survey.

there is no direct comparative information on immigrant and native wealth in Switzerland, several indicators suggest that average native wealth is higher. One measure is salary and employment. Immigrants in Switzerland on average earn less and are more likely to be unemployed than natives. According to the BfS (2008), the median monthly salary for immigrants was just over CHF 5,000 in

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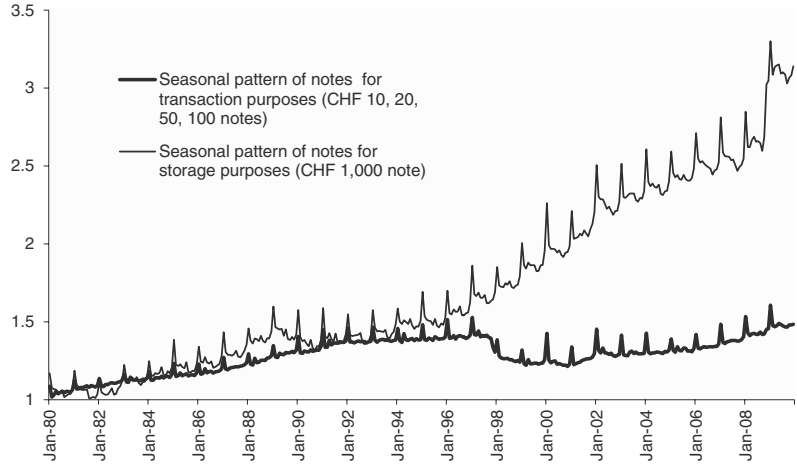


FIGURE 1. Seasonal pattern of notes for transaction and storage purposes.

2006, whereas for natives it was just under 6,000. Similarly, the unemployment rate for immigrants was 7.1% in 2006, whereas the rate for natives was only 2.6%. A further measure of wealth is homeownership. Again according to the BfS (2008), native homeownership stood at 52.7% in 2007:Q2, whereas immigrant homeownership was just 18.6%. The incentive to avoid wealth taxes on the part of wealthier natives means that a negative (seasonal) correlation between immigrant municipalities and large-denominated notes is expected.

The third hypothesis is based on remittances. Jankowski et al. (2007) argue that remittances operating through global cash transfer services are attractive for immigrant groups that send cash to recipient countries with weak financial infrastructures. This practice is widespread in the United States and Saudi Arabia.

Anecdotal evidence for Switzerland is unclear. On the one hand, the high concentration of cash transfer services offered in Switzerland (over 3,500 offices) is supportive of the remittance hypothesis. On the other hand, the small estimated size of remittances to poor countries speaks against this hypothesis. Arapovic and Brown (2009) estimate the total amount of remittances to the Balkans and Turkey, representing the immigrant groups most likely to use cash transfer services. The estimated sum is only CHF 0.7 billion for 404,000 immigrants in 2006. This total yields CHF 1,700 per immigrant, an amount well below the average holdings of three CHF 1,000 notes per person. A further observation is that immigrants from the Balkans and Turkey compose only 25% of the immigrant population living in Switzerland. It is unlikely that these two immigrant groups at the municipality level can influence the demand for large banknotes in the aggregate.

The fourth hypothesis is financial participation. This hypothesis is again motivated by the U.S. experience. Jankowski et al. (2007) show empirically for the

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Chicago area that Hispanics, in contrast to other immigrant groups, hoard US$100 notes. The conjecture advanced by the authors is that Hispanics hardly use banking services. Frictions for these services include lack of a common language, lack of residence documentation, and salary payments by cash or check.

It is unclear how important the "unbanked" hypothesis is for immigrants in Switzerland. Independent of their skill levels or language skills, employees in Switzerland need bank accounts to receive their salary. Almost all salary payments in Switzerland are electronic transfers. Despite their having salary accounts, an open issue is whether immigrants utilize financial services offered by banks to the same degree as natives. It may be the case that immigrants use credit cards less frequently and are more reliant on cash to conduct their large purchases.[13] If true, this would lead to a positive correlation between banknotes and the immigrant-to-native ratio.

3. ECONOMETRIC SPECIFICATIONS AND DATA

This section first presents the empirical model together with the instrumentation strategy. Empirical estimates from the first-stage regression are shown. In a second subsection, the data are discussed.

3.1. Empirical Specification

The econometric model estimates the demand effect of immigrants relative to natives of a Swiss municipality on banknote orders in the same city. Banknote orders are volume measures in Swiss francs for six banknotes: CHF 10, CHF 20, CHF 50, CHF 100, CHF 200, and CHF 1,000.[14] The following specification, adapted from Lach (2007) and Frattini (2008), defines the banknote order, BO_{mt}, for municipality m ($m = 1, \cdots, 251$) for time t covering the quarterly sample from 2006:Q1 to 2007:Q4 (defined by data availability) as

$$\ln \mathrm{BO}_{mt} = \mu_t + \mu_m + \delta(I_{mt}/N_{mt}) + \beta \ln(I_{mt} + N_{mt}) + \lambda X_{mt} + u_{mt}, \qquad (1)$$

where I_{mt} and N_{mt} are the numbers of immigrants and natives in municipality m in quarter t, μ's are time and municipality effects, X_{mt} are additional municipality-specific factors (e.g., the unemployment rate serves as a proxy for economic activity, or overnight stays capture tourism effects), and u_{mt} is a shock to banknote orders in quarter t. Total population, $(I_{mt} + N_{mt})$, which captures size effects, should be positively correlated with banknote orders. The size effects of different notes may be nonlinear because the distribution of ATM services is greater in larger cities.[15]

The coefficient of interest in equation (1) is δ. A nonsignificant coefficient estimate for I/N says that preferences for banknote holdings are similar between immigrants and natives.[16] Alternatively, when δ is positive, this says that immigrants in Switzerland have strong preferences for holding large banknotes.

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Such behavior is consistent with remittances or a lack of financial participation. Alternatively, when δ is negative, this says that possible immigrant traits such as age or education are captured through I/N.

Although equation (1) is not subject to the endogeneity conundrum between supply and demand (banknote orders are demand-driven), other estimation issues need to be addressed. First, omitted variables, such as prices or income unavailable at the municipality level, influence an immigrant's decision to reside in a particular Swiss city and are certainly correlated with banknote orders.[17] The omitted variables problem biases the estimates of δ in (1). In the case of rising income, this leads to an upward-biased estimate of δ.

Second, potential measurement problems with the immigrant stock raise concerns of attenuation bias for the estimate of δ [see Aydemir and Borjas (2011)]. Immigration is measured as the number of foreign nationals residing in Switzerland. Because the immigration stock varies in response to naturalized citizens and births of foreign nationals, our measure of immigration is contaminated. This measurement problem drives the OLS estimate of δ toward zero. Although at the national level the difference between foreign nationals and foreign-born population is small by international comparisons, it is difficult to determine how large the measurement problem is across regions.[18]

I resolve problems both of omitted variables and of measurement error by instrumenting for I_{mt}/N_{mt}. The instrumental variable is based on settlement patterns of previous immigrants. Following Card (2001), I construct a variable that predicts immigrant flows for each municipality and for each quarter.[19] The intuition is to exploit the location choices of past immigrants from each area of origin to predict settlement decisions of immigrants from the same country. The instrument variable predicts the immigrant stock filtering local contemporary demand factors.

The instrument's construction involves several steps. In a first step, immigrants are divided into 11 countries of origin. I then calculate I_{it}, the number of immigrants from each country, i, who reside in Switzerland in quarter t.[20] Next, the fraction of immigrants from country , in municipality m is the quarterly average for the year 2004, $\bar{\lambda}_{mi} = \bar{I}_{mi}/\bar{I}_i$. The predicted number of immigrants from country i in quarter t is $\bar{\lambda}_{mi} I_{it}$. By summing over i, a measure of the predicted total immigrant inflow into municipality m at time t is obtained that is free of local shocks. A final step normalizes the instrument by the number of natives in the municipality two years before at $t-8$:

$$\mathrm{SP}_{mt} = \sum_{i=1}^{11} \frac{\bar{\lambda}_{mi} I_{it}}{N_{mt-8}}. \tag{2}$$

The regression of the immigrant-to-native ratio on the supply push instrument, SP_{mt}, offers a simple test of an instrument's strength. Table 2 presents OLS regressions from 2006:Q1 to 2007:Q4 with municipality effects. In each regression, the instrument has a t-value above 5, suggesting that SP passes the critic of weak instruments. The first regression in column (1) is unrestricted. It includes

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TABLE 2. Immigrant-to-native ratio and the instrument SP

	Unrestricted (1)	Restricted CHF 1,000 only (2)	Restricted CHF 1,000 only (3)	Restricted CHF 1,000 only (4)
SP	1.690***	1.730***	1.931***	2.028***
	(0.310)	(0.1760)	(0.424)	(0.400)
ln population	no	no	no	yes
Unemployment/ population	no	no	no	yes
Time effects	no	no	yes	yes
Number of observations	20,414	1,859	1,859	1,859
Number of cities	2675	243	243	243

Notes: Estimation is OLS with fixed (city) effects. SP is the instrument. Sample is from 2006:Q1 to 2007:Q4. Standard errors are in parentheses. *, **, *** denotes significance at the 10%, 5%, and 1% level.

information on immigrants from 2,675 municipalities. Next, in column (2), the sample is restricted to 243 municipalities receiving banknote orders for CHF 1,000 notes in 2006 and 2007. Column (3) shows the restricted first-stage regression of column (2) with time effects. The last specification, in column (4), which is used in the analysis in Section 4, includes ln population and the unemployed-to-population ratio in the specification of column (3).

3.2. The Data

The quarterly sample from 2006:Q1 to 2007:Q4 covers a maximum of 251 municipalities.[21] Data on banknote orders at the bank-branch level are aggregated to the municipality level. The quarterly data are from UBS, the largest national distributor of banknotes in Switzerland.[22] Banknote orders across municipalities should be treated as homogenous in that UBS note distributors have monopoly power at the local level in that they serve several banks (i.e., UBS and other banks). Further, they operate with equal delivery times (i.e., two and one-half hours or less) for the served municipalities. UBS handles roughly one-third of the banknote distribution activity in Switzerland.

The broad coverage of banknote orders is first shown graphically, followed by statistical information that confirms this result. UBS's distribution is shown in Figure 2. The darker shaded dots denote the banks served by UBS and the lighter shaded dots depict the remaining municipalities in Switzerland. The sparse areas in Figure 2 are consistent with Switzerland's mountain regions.

Table 3 provides statistical information on banknote orders that confirms the broad-based coverage by UBS. The first column shows the number of municipalities served. They range between 199 and 251, depending on the banknote's size. Column (2) shows the percentage of German-speaking municipalities served.

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FIGURE 2. Swiss cities with cash orders.

TABLE 3. Statistics on UBS banknote orders

	(1) Total cities	(2) German-speaking cities only	(3) Average per quarter	(4) Min	(5) Max	(6) St. dev.	(7) Ave. note order to Ave. outstanding
CHF 10	199	0.754	3.0	2.3	3.8	0.6	0.005
CHF 20	249	0.715	194	169	213	14.7	0.148
CHF 50	173	0.867	188	150	229	26.7	0.106
CHF 100	242	0.736	948	835	1,280	149.0	0.125
CHF 200	251	0.708	2,760	2,560	3,110	178.0	0.461
CHF 1,000	244	0.713	2,220	1,870	2,840	392.0	0.102

Notes: Total cities are number of cities covered by UBS banknote orders. German-speaking cities are the ratios of German-speaking cities to total cities served by UBS. Average per quarter denotes the average banknote volume for a particular banknote in millions.
Min and max are with respect to the quarterly volume from 2006:Q1 to 2007:Q4. St. dev. is the standard deviation in millions.
Ave. note order to ave. outstanding is the ratio of the average quarterly volume of banknote orders to the quarterly average of notes in circulation.

Apart from the CHF 50 note, the currency percentages lie close to the national average of 72% for the German-speaking population. Next, columns (3) to (6) provide information on the average, the minimum and the maximum, and the standard deviation of the quarterly total of the distributed currency. In the last column, the quarterly average from column (3) is divided by the average quarterly

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outstanding currency for the respective banknote. Except for the CHF 10 and the CHF 200 banknote, the percentages lie between 10% and 15%. The low percentage for the CHF 10 note (0.005%) suggests that UBS coverage is problematic for the smallest banknote, whereas the distribution of the CHF 200 note (46%) may be overrepresented with respect to the others. Because of the broader coverage of the CHF 200 note, this banknote is included in the empirical analysis as a control for the regression estimates for the CHF 1,000 notes.

The postal code from the banknote orders is matched with other data sources. From the Federal Office for Migration, I obtained data on the number of foreigners for each municipality in Switzerland, grouped by their origin. The data are available at a quarterly frequency. The quarterly variable on overnight hotel stays by foreigners, which seeks to capture a tourism effect, is from the Federal Office of Statistics. Further, the number of unemployed workers for each community is from the State Secretariat for Economic Affairs. The monthly data are averaged at the quarterly frequency. In addition, I obtained data on the total resident population for each municipality from the Federal Office of Statistics. The population data, available only at the annual frequency, are disaggregated by a linear interpolation over a 20-year period from 1989 to 2008.

4. EMPIRICAL RESULTS

This section presents the empirical results. In the first subsection, the main result for large banknotes is documented: the correlation between banknote orders and the immigrant-to-native ratio is negative. The second subsection presents robustness tests that control for income effects by excluding geographical areas where poorer natives reside (i.e., mountainous and rural areas). These results show that the hoarding effect is linked to wealthier natives. The third subsection presents empirical results that examine the seasonal pattern of equation (1) used to test the tax evasion hypothesis. Robustness checks show that specific economic traits are linked to immigrants and that this observation is consistent with a precautionary-demand-for-money interpretation.

4.1. The Main Results

Table 4 presents OLS and IV regression estimates for CHF 200 and CHF 1,000 banknote orders. All regressions are for the full sample and control for municipality effects. The coefficient estimates for the immigrant-to-native ratio and population are sensitive to estimation type and the introduction of time effects. In the OLS and IV regressions, the introduction of time effects lowers the coefficient estimates for the immigrant-to-native ratio. This result says that macroeconomic trends, such as interest rates, interact strongly with the immigrant-to-native ratio. Further, the introduction of the unemployed-to-population ratio is positive, reflecting the view that immigrant unemployment is highly concentrated in larger cities. This variable,

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TABLE 4. Immigrant-to-native ratio and large banknotes

	CHF banknotes							
	200 (1)	*200* (2)	*200* (3)	*200* (4)	*1,000* (5)	*1,000* (6)	*1,000* (7)	*1,000* (8)
				OLS estimation				
Immigrant/natives	−0.042	0.500	−0.421	−0.472	3.523***	2.727***	0.753	0.725
	(0.950)	(0.983)	(0.909)	(0.910)	(0.213)	(0.791)	(0.622)	(0.603)
ln population		−2.099***	−0.321	−0.281		3.058**	0.473	0.495
		(0.784)	(0.800)	(0.802)		(1.077)	(1.048)	(1.046)
Unemployment/population				4.839*				3.382
				(2.584)				(2.366)
Time effects	no	no	yes	yes	no	no	yes	yes
Number of observations	1,911	1,911	1,911	1,911	1,859	1,859	1,859	1,859
Number of cities	249	249	249	249	243	243	243	243
R-squared	0.940	0.942	0.945	0.945	0.930	0.930	0.954	0.961
				IV estimation				
Immigrant/natives	−9.790***	−10.845**	−21.047***	−20.586***	9.206***	7.741**	−7.703*	−7.416*
	(3.412)	(4.411)	(6.313)	(6.241)	(2.928)	(3.746)	(4.129)	(4.091)
ln population		1.188	5.192**	5.106**		1.651	2.753*	2.693*
		(1.716)	(2.202)	(2.185)		(1.465)	(4.129)	(1.464)
Unemployment/population				6.586**				3.913*
				(3.315)				(2.314)
Time effects	no	no	yes	yes	no	no	yes	yes
Number of observations	1,911	1,911	1,911	1,911	1,859	1,859	1,859	1,859
Number of cities	249	249	249	249	243	243	243	243
R-squared	0.130	0.001	0.061	0.063	0.175	0.286	0.115	0.120
F-test (first stage regression)	184.3	129.95	34.24	31.10	181.04	127.83	33.81	30.65

Notes: Estimation is OLS or IV with fixed (city) effects. Sample is from 2006:Q1 to 2007:Q4. Standard errors are in parentheses.
*,**, *** denotes significance at the 10%, 5%, and 1% level.

however, does not influence the coefficient estimates for the immigrant-to-native ratio.

OLS estimates find that the immigrant-to-native ratio is nonsignificant. These estimates are presented in the top panel of Table 4. The immigrant-to-native ratios are nonsignificant for the CHF 200 banknotes in all regressions. The introduction of municipality size (natural log population), economic activity (unemployed-to-population ratio), natural log of overnight hotel stays, or time effects does not change the result that the demand for CHF 200 banknotes does not differ between immigrants and natives. In each of these regressions, the variable of interest is nonsignificant and the size effects captured by population have the wrong sign.

A somewhat similar picture emerges for the OLS estimates for the CHF 1,000 notes. The immigrant-to-native ratio is positive and significant in the regression without time effects; see columns (6) and (7) versus column (8). The introduction of time dummies reduces the coefficient estimate of the immigrant-to-native ratio fourfold and eliminates its significance; see columns (8) to (10). The introduction of population, the unemployed-to-population ratio, or overnight stays has no significant bearing on the results for the immigrant-to-native ratio.

Next, IV estimates reveal that immigrant municipalities hoard fewer larger banknotes. The bottom panel of Table 4 shows IV estimates of different specifications of equation (1). The F-tests from the first-stage regression are all high, suggesting that the critic of weak instruments does not apply. The coefficient estimates for the immigrant-to-native ratio are negative and significant at the 1% critical level in the regression for the CHF 200 banknotes. The coefficient size for I/N jumps from -10 to -20 with the introduction of time effects. In other words, a 1% increase in the immigrant-to-native ratio leads to a reduction by CHF 4,000. This result is partially compensated for by population size by CHF 1,000 (i.e., it has a coefficient size of 5).[23] These results are not sensitive to the introduction of the unemployed-to-population ratio. This latter variable enters with a positive coefficient and is significant at the 5% level. The introduction of overnight stays in column (5) is significant and mitigates the population effect without influencing the coefficient on the immigrant-to-native ratio.

The IV estimates for CHF 1,000 banknotes are similar to those for CHF 200 banknotes. The coefficient estimates for I/N fall from 7.7 to-7.7 with the introduction of time effects; see columns (6) and (7). The coefficient estimates of I/N are negative and significant at the 10% level in regressions with time effects; see columns (8) to (10). The regressions with time effects show that a 1% increase in the immigrant-to-native ratio leads to a CHF 7,000 reduction in the demand for large banknotes. This result is compensated for by population size on the order of CHF 3,000. As for the CHF 200 note, hotel stays in column (10) capture size effects rather than separate tourist effects. Thus, the preferred specifications in Table 4 are columns (4) and (9). These regressions are estimated with greater degrees of freedom and show positive and significant size effects for population.

Next, I examine whether the disproportionate effect between immigrants and natives for large banknotes holds for other banknote denominations. A significant

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TABLE 5. Immigrant-to-native ratio on currency orders of different denominations

	CHF banknotes					
	10	20	50	100	200	1000
Immigrant/natives	−11.465	−21.938**	7.476	−11.936	−20.568***	−7.416*
	(14.095)	(8.715)	(11.831)	(7.753)	(6.241)	(4.091)
Number of observations	896	1,764	1,497	1,884	1,991	1,859
Number of cities	198	248	241	250	249	243
R-squared (first stage within)	0.239	0.163	0.156	0.161	0.158	0.163
F-test (first stage regression)	21.64	29.25	23.01	31.24	31.10	30.65

Notes: Only the estimates of the immigrant-to-native ratio from an IV regression with fixed effects at the city time level (which includes ln population, unemployment/population, and time effects) are shown.
F-test(10, observations-cities-10) is from the first stage regression, which includes the instrument [see equation (2)].
Sample is from 2006:Q1 to 2007:Q4. Standard errors are in parentheses.
*,**, *** denotes significance at the 10%, 5%, and 1% level.

negative result across all banknote denominations is consistent with the traditional and not the precautionary demand for money. The IV regressions in Table 5 are based on specifications 4 and 8 in Table 4. Only the coefficient estimates for the immigrant-to-native ratio are shown.

The empirical results for various banknotes show that the immigrant demand for smaller banknotes is not distinct from the demand by natives, except for the CHF 20 notes. The coefficient estimates are nonsignificant for the CHF 10, the CHF 50, and the CHF 100 banknote, whereas for the CHF 20 note they are negative and significant at the 5% level. These results are consistent with the precautionary demand specification and the view that natives hoard larger banknotes.

A further consideration is whether the hoarding of large CHF banknotes by natives is more pronounced with a particular immigrant group linked to education. If education matters for the adoption of new financial technologies, then the demand for large banknotes by well-educated immigrants should be lower than that for less educated immigrants. To test this claim, I examine the behavior of the four largest immigrant groups in Switzerland: Germans, Italians, Serbians, and Portuguese. A striking feature is that these nationals have different levels of education. German immigrants have the highest percentage of university degrees (64% in 2007; see Table 1), whereas the Portuguese have the lowest (6% in 2007). The IV regressions in Table 6 again show only the estimates of the immigrant-to-native ratio for specifications 4 and 8 in Table 4 for the CHF 200 and CHF 1,000 banknotes. The instruments have been adjusted so that only the fixed immigrant share at the municipality level in 2004 is multiplied by the aggregate of the respective immigrant group.[24]

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TABLE 6. Ethnic cities and large banknote orders

	CHF 200 banknote			
Immigrant group	Germans	Italians	Serbians	Portuguese
Immigrant/natives	−19.277***	−69.889	−593.963	−8.516
	(5.592)	(63.580)	(848.131)	(22.308)
Number of observations	1911	1911	1911	1911
Number of cities	249	249	249	249
R-squared (first stage within)	0.576	0.142	0.112	0.123
F-test (first stage regression)	224.79	27.31	20.84	23.06
	CHF 1,000 banknote			
Immigrant group	Germans	Italians	Serbians	Portuguese
Immigrant/natives	−0.864	−80.994*	1.020	−6.368
	(3.944)	(47.887)	(161.464)	(15.985)
Number of observations	1859	1859	1859	1859
Number of cities	243	243	243	243
R-squared (first stage within)	0.582	0.144	0.115	0.125
F-test (first stage regression)	223.33	27.10	20.84	22.94

Notes: Only the estimates of the immigrant-to-native ratio from an IV regression with fixed effects at the city time level (which includes ln population, unemployment/population, and time effects) are shown.
F-test(10, observations-cities-10) is from the first stage regression, which includes the instrument [see equation (2)]. Sample is from 2006:Q1 to 2007:Q4. Standard errors are in parentheses.
*,**, *** denotes significance at the 10%, 5%, and 1% level.

The IV regressions for immigrant groups show that the coefficients are all negative except for Serbian immigrants in the demand specification for CHF 1,000 notes. The negative and significant results for the more educated immigrants (i.e., Germans with CHF 200 notes and Italians with CHF 1,000 notes) are consistent with the micro evidence in Mulligan and Sala-i-Martin (1996) that finds education to be negatively correlated with money demand. Because the significance for the better educated immigrants is not uniform across the large banknotes, the evidence that the immigrant-to-native ratio is capturing demographic effects related to education must be interpreted as weak.

4.2. Controlling for Municipal and Regional Characteristics

This subsection presents robustness checks for the result that natives hoard large banknotes. The robustness checks control for income and nonlinear effects with sample splits for municipality and regional characteristics. The evidence shows that these factors are non neutral, however the main result that natives hoard more than immigrants holds.

The first set of regressions presents coefficient estimates for I/N that control for municipality characteristics linked to wealth. Panel A of Table 7 divides the sample based on a municipality population below or above 10,000 residents for

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TABLE 7. City characteristics, immigrant-to-native ratios, and banknote orders

	CHF banknotes			
	200	200	1,000	1,000
	A: City population < 10,000			
	yes	no	yes	no
Immigrant/natives	−22.799**	−11.592	−5.454	−9.052*
	(8.965)	(8.375)	(6.459)	(4.796)
Number of observations	1096	815	1060	799
Number of cities	143	107	139	105
R-squared (first stage within)	0.144	0.224	0.143	0.234
F-test (first stage regression)	15.79	20.10	15.21	20.91
	B. Special tax treatment			
	yes	no	yes	no
Immigrant/natives	−132.339	−18.146***	91.544	−10.533***
	(363.628)	(6.302)	(126.117)	(3.970)
Number of observations	343	1569	333	1526
Number of cities	43	206	42	201
R-squared (first stage within)	0.050	0.186	0.046	0.188
F-test (first stage regression)	1.50	30.94	1.34	30.44

Notes: Only the estimates of the immigrant-to-native ratio from an IV regression with fixed effects at the city time level (which includes ln population, unemployment/population, and time effects) are shown.
F-test(10, observations-cities-10) is from the first stage regression, which includes the instrument [see equation (2)].
Sample is from 2006:Q1 to 2007:Q4. Standard errors are in parentheses.
*,**, *** denotes significance at the 10%, 5%, and 1% level.

the CHF 200 and CHF 1,000 note. The conjecture is that larger municipalities are wealthier and thus the immigrant effect should be stronger with the CHF 1,000 note than with the CHF 200 note.

Indeed, this is what the regressions controlling for population size show. The regressions show strong evidence of native hoarding for CHF 200 notes in smaller municipalities. The opposite result holds for the largest banknote in the larger municipalities. The immigrant-to-native ratio is negative and significant at the 10% level for large municipalities. This hoarding result is consistent with the fact that incomes are higher in larger municipalities.

The role of special tax reductions is examined next. To do so, the sample is divided between municipalities that are exempt from special taxes because of their weak fiscal position. The estimates are recorded in panel B of Table 7. The coefficient estimates for I/N show that municipalities not benefitting from the tax reduction, hoarding prevails. These coefficient estimates are close to the full sample estimates recorded in Table 4, but their level of significance is higher. The nonsignificant estimates for the sample of municipalities enjoying tax benefits, however, must be interpreted with care. The sample size is small and the *F*-test values from the first-stage regressions are low.

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TABLE 8. Geographical characteristics, immigrant-to-native ratios, and banknote orders

	CHF banknotes			
	200	200	1,000	1,000
	A: Rural area			
	yes	no	yes	no
Immigrant/native	−63.301	−15.416**	12.297	−10.075***
	(68.018)	(6.239)	(20.009)	(3.881)
Number of observations	608	1,303	595	1,264
Number of cities	79	170	77	166
R-squared (first-stage within)	0.128	0.211	0.129	0.211
F-test (first stage regression)	7.64	30.04	7.50	29.13
	B: Alp—mountain area			
	yes	no	yes	no
Immigrant/native	−10.658	−20.098***	4.961	−11.760**
	(7.338)	(7.814)	(6.638)	(4.762)
Number of observations	762	1,149	760	1,099
Number of cities	98	151	98	145
R-squared (first-stage within)	0.220	0.169	0.222	0.174
F-test (first stage regression)	18.46	20.09	18.57	19.85

Notes: Only the estimates of the immigrant-to-native ratio from an IV regression with fixed effects at the city time level (which includes ln population, unemployment/population, and time effects) are shown.
F-test(10, observations-cities-10) is from the first stage regression, which includes the instrument [see equation (2)]. Sample is from 2006:Q1 to 2007:Q4. Standard errors are in parentheses.
*,**, *** denotes significance at the 10%, 5%, and 1% level.

The next robustness test considers the influence of regional location on the distribution of CHF 200 and CHF 1,000 banknote orders. Table 8 splits the sample at the municipal level in two ways: rural versus urban areas and mountain versus lowland regions. The sample splits are motivated by the location of commercial activity: agriculture sector (rural) and tourism (mountain region). The agricultural (8.1% immigrant labor participation in 2006) and tourist (51%) sectors control for income effects and contrasting immigrant participation rates in the labor force.

Again, the results from the sample split on rural versus nonrural areas reconfirm the conjecture that wealthier natives are driving the demand for large banknotes. Panel A of Table 8 shows regression results for rural and nonrural areas. This sample split controls for higher-income effects and higher labor participation effects on the part of immigrants in nonrural areas. Only for the nonrural areas is a negative and significant result found. The result for the rural areas instead has to be interpreted with caution because of the low *F*-test values from the first-stage regressions.

Further tests based on elevation reveal that the wealthier low land regions generate the strongest negative correlation with immigrant municipalities. Panel B of Table 8 shows regression results for high- and low-elevation municipalities

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(i.e., 800 m or more). Only for the low-elevation municipalities is a negative and significant result for I/N observed.[25] The estimates for the immigrant-to-native ratio are nonsignificant for mountain municipalities. The nonsignificance result is consistent with the fact that incomes of municipalities in the mountain areas lie well below the national average.

4.3. Seasonal Patterns and Tax Evasion

The empirical results in the previous section show that a higher level of native wealth is associated with a negative correlation between large banknotes and the immigrant-to-native ratio. This negative correlation is inconsistent with the unbanked and the remittance hypotheses. However, whether the negative coefficient for the immigrant-to-native ratio captures tax evasion or wealth effects in a precautionary demand function remains an open issue.

A simple test for tax evasion examines seasonal patterns between banknote orders and immigration. Such a seasonal pattern is defined by a strong rise in the demand for banknotes in the fourth quarter in year t followed by a sudden fall in the demand for banknotes in the first quarter in year $t + 1$. The rationale for this seasonal pattern is that higher banknote holdings in the fourth quarter lead to a lower end-of-year balance on financial statements used for tax declarations. In contrast, reduced banknote holdings in the first quarter next year compensate for the loss on forgone interest income.

The quarterly regression results uncover a seasonal pattern only partially consistent with tax evasion. Table 9 reruns the IV regressions of Table 4 of columns (4) and (8) for individual quarters. Because of the low degrees of freedom, the results need to be treated with caution. Despite this shortcoming, the quarterly estimates for the CHF 200 and the CHF 1,000 notes are significant at the 10% level only for the fourth quarter. Further evidence for the tax evasion hypothesis rests in the fact that the coefficient estimates for the fourth quarter are smaller than those for the first quarter.

5. CONCLUSIONS

This paper is the first country study to examine immigration's effect on banknote circulation. The empirical results show that immigrant municipalities have a lower demand for large banknotes. In other words, immigration reduces seigniorage per person as measured by banknote orders. Controlling for population size, a 1% increase in the native-to-population ratio lowers the demand for the CHF 1,000 banknote by CHF 4,000. A similar immigrant effect is found for the CHF 200 note, whereas for the lower-denominated notes no effect is identified.

The lower demand for large banknotes on the part of immigrants is inconsistent with the unbanked and remittances hypotheses. Although I find only weak evidence of a seasonal pattern linked to the tax-evasion hypothesis, the results do suggest that specific immigrant traits such as lower average age and lower average wealth

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TABLE 9. Seasonal vharacteristics, immigrant-to-native ratios, and banknote orders

	Q1	Q2	Q3	Q4
	CHF 200 banknotes			
Immigrant/native	−7.836	−52.52*	−200.791	−12.734*
	(9.856)	(30.052)	(807.577)	(7.219)
Number of observations	486	476	475	474
Number of cities	246	246	249	247
R-squared (first stage within)	0.093	0.078	0.225	0.392
F-test (first stage regression)	6.01	4.80	16.10	35.72
	CHF 1,000 banknotes			
Immigrant/native	−4.740	−7.527	48.306	−9.425*
	(6.021)	(11.351)	(132.139)	(5.610)
Number of observations	471	463	461	464
Number of cities	241	241	240	242
R-squared (first stage within)	0.118	0.074	0.211	0.393
F-test (first stage regression)	7.54	4.34	14.67	35.28

Notes: Only the estimates of the immigrant-to-native ratio from an IV regression with fixed effects at the city time level (which includes ln population, unemployment/population, and time effects) are shown.
F-test(10, observations-cities-10) is from the first stage regression, which includes the instrument [see equation (2)]. Sample is from 2006:Q1 to 2007:Q4. Standard errors are in parentheses.
*, **, *** denotes significance at the 10%, 5%, and 1% level.

captured in the immigrant-to-native ratio can be important for understanding distributional effects on precautionary demand for money.

NOTES

1. The EUR 500 note is the second largest banknote in nominal value. Historically, the EUR/CHF exchange rate has hovered around 1.5, yielding 666 euros per CHF 1,000 note.

2. Recent micro studies include Fujiki (2002), Bover and Watson (2007), and Fischer (2007). See also the earlier studeis by Mulligan and Sala-i-Martin (1992), Fujiki and Mulligan (1996), and Mulligan (1997). In a related study, Jankowski et al. (2007) match banknote orders with Hispanic immigrant concentration for the Chicago area using census data from 2000. It is unclear, however, whether their cross-section estimates are valid at the state or national level.

3. Because it is largely believed that Swiss banknotes do not leave the national borders, the hypothesis of currency substitution is not considered; see Porter and Judson (1996) for the United States and Maradan (2007) for Switzerland. This observation is confirmed by the United Kingdom's recent ban on handling EUR 500 notes. Since May 15, 2010, British banks and currency exchanges have been banned from importing EUR 500 notes because of fears of organized crime. The UK ban does not apply to CHF 1,000 notes, because there is no widespread evidence of their use. Another hypothesis that is advanced but does not apply to Switzerland is the link between large banknotes and the informal sector [see Rogoff (1998)]. Schneider (2008), for example, finds that the Swiss informal sector is smaller than 8%, which is small by international standards.

4. Although many European countries have good regional data on immigration flows, additional demographic information is often difficult to obtain. Hence, in a precautionary money demand function, the immigrant-to-native ratio may serve as a simple proxy for omitted variables. Crucial is that average immigrant traits differ from average native traits.

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5. Tin (2008), for example, using information from the Survey of Income and Program Participation, estimates a precautionary money demand function for U.S. households that includes family traits. He finds that age and education correlates positively with non-interest earning checking accounts. Similarly, Duca and Whitesell (1995) show that age correlates positively with the demand for credit cards.

6. Information from the most recent 2000 census shows that the average age of Swiss residents is 39.3 for natives versus 33.7 for immigrants. The average age differences are even larger for large municipalities (i.e., population greater than 10,000): 42.8 for natives versus 32.7 for immigrants. These results show that the average age of immigrants is evenly distributed across municipalities, whereas the average age of natives is heavily skewed toward larger cities.

7. The level of education is not uniform across immigrant groups. This feature will be tested in the empirical section.

8. A hypothesis similar to education is criminal activity (i.e., drug trade) committed by immigrants. Aggregate criminal records show that foreigners make up a large percentage of the Swiss prison population. However, I am unable to control for crime at the local level, because the records are incomplete and inconsistent across cantons.

9. Several other European countries impose a wealth tax. They include France, the Netherlands, Norway, Greece, and Liechtenstein. This tax was recently lifted in Austria (1997), Finland (2006), Germany (1997), Iceland (2006), Luxembourg (2006), Sweden (2007), and Spain (2008). Countries without a wealth tax include Belgium, Italy, Portugal, and the United Kingdom.

10. For a discussion on seasonality and monetary policy, see Gomis-Porqueras and Smith (2003).

11. The seasonal pattern for the CHF 1,000 notes does not match the seasonal pattern for retail sales, new automobile registration, and overnight stays. This suggests that large banknotes are not tightly correlated with large consumption purchases at the seasonal frequency.

12. The rise in the volume of CHF 1,000 notes relative to the other notes starting in 1997 is partially explained by the introduction of the CHF 200 note, which replaced the CHF 500 note in the same year. The newly introduced note is used both for transaction and storage purposes, whereas the CHF 500 banknote is used primarily for storage.

13. See Choi (2011) on the distributional effects of monetary policy, stemming from the use of different payment methods.

14. See Redish and Weber (2011), regarding issues on the optimal denomination.

15. See Lach (2007) for a discussion of nonlinear effects for population in a similar specification for CPI prices.

16. Obviously, the extreme cases of $I/N = 0$ or 1 would allow two separate regressions for native and immigrant demand functions to be tested. However, these extreme cases do not arise.

17. An important assumption is that the I/N ratio does not simply reflect income, which is controlled for separately by employment.

18. Swiss record-keeping of immigrants follows the "ius sanguinis" concept. In 2006, foreign nationals were 20.2% of the population, whereas foreign-born were 22.9% of the population. See Table 3 in Münz (2008) for European comparisons.

19. Lach (2007), Cortes (2008), and Frattini (2009) use the same instrument strategy in a specification similar to equation (1).

20. The European countries of origin are Austria, France, Germany, Italy, the Netherlands, Serbia, Portugal, Serbia, Spain, Turkey, the United Kingdom, and others.

21. Figure 1 shows that the financial crisis of 2007–2009 did not affect our sample. The change in the seasonal pattern for the CHF 1,000 note was pronounced in 2008:Q4.

22. Most distributors operate only regionally. The distribution of banknotes is fully privatized in Switzerland. Information on the location of notes returned to the Swiss National Bank is unavailable.

23. This estimate needs to be treated with caution in that population is not necessarily exogenous in this specification; see Lach (2007). The results are not sensitive to whether N or $(I + N)$ is used to control for size effects.

24. Data for Swiss education levels at the local level are not available for the observed sample.

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25. High elevation (central Alps region) also controls for cross-border effects for towns situated inatlow elevation. Border town consumers are more likely to shop in Germany and France and are thus less inclined to hold large banknotes. Even in this case of border towns, the negative immigrant effect is strong.

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