

Supplementary material for

**How Amsterdam got Fiat Money**

Stephen Quinn, Texas Christian University

William Roberds, Federal Reserve Bank of Atlanta

## Appendix A: AWB Accounting

### I. The Balance Sheet

The AWB fiscal year ended of January, so the bank’s balance sheet sums categories on January 31. In bank guilders, the AWB reported its assets as metal held and loans due, its liabilities were account balances, and the residual was capital. See Table 1 in the text for an example. Van Dillen (1925: 701-807) reproduces these from AWB records, and we have consolidated them for our sample period in Table A1.

Because the balance sheet is a double entry system, changes in year-to-year balances have an offsetting change, so bank operations can be organized within a matrix. Figure A1 shows the possibilities and assigns different AWB operations to the appropriate categories. Traditional deposits and withdrawals are only the start. In particular, credit activity follows from changes in metal levels or account levels without an offsetting change in the other. Put differently, metal derives from activity in the other two categories: capital and loans.

**Figure A1. Cross-Category AWB Operations**

	<b>Metal</b>	<b>Loans</b>	<b>Capital</b>
<b>Account</b>	Deposits Withdrawals Bullion purchases and sales	“Account” Lending: All VOC, Some Amsterdam	VOC Interest Some Expenses
<b>Capital</b>	Fee Revenue Holland Interest Most Expenses Special Deposits Open Market Profit/Loss	Interest Due Loan Write-Offs	
<b>Loans</b>		“Metal” Lending: All Holland, All Miscellaneous, Some Amsterdam	

#### *Loans*

Loans were granted by creating account balances (VOC) or by releasing metal (Holland). Amsterdam used both techniques. Principal repayment reversed the process.

#### *Capital Accumulation*

Capital grew through the bank’s retained earnings. Interest payments by account eliminated bank guilders while interest payments by metal increased the bank’s metal stock. If the bank

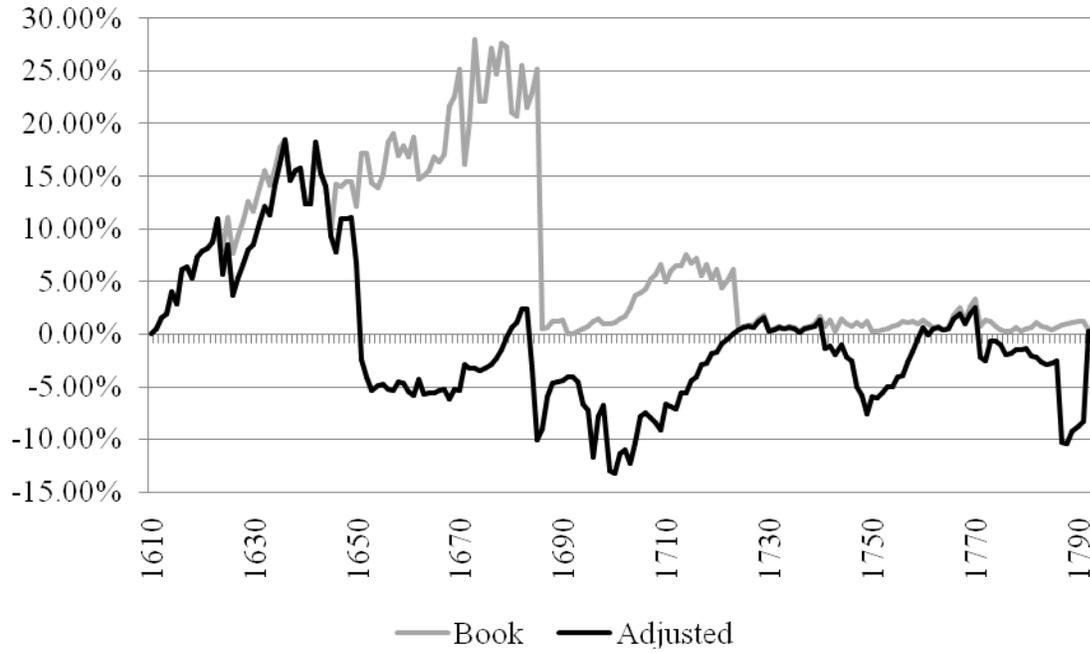
considered interest due on January 31, then the AWB added the interest due to the loan's principal and to the bank's capital at that time. Other revenue from fees on withdrawals, account overdrafts, receipts and money changing were collected in coin, so the metal stock increased from those operations.

### *Capital Extraction*

Removing capital was the prerogative of the City of Amsterdam. When the city decided to extract retained earnings, it did so by "borrowing" from the AWB at no interest *instead* of reducing capital. It appears the city did this to avoid explicitly putting the AWB into a negative capital. This situation seems to have evolved. In the early 1650s, the city borrowed around 2 million guilders from the AWB to help build a new city hall (and home for the bank) on the Dam. Soon, the city stopped paying interest, for why pay your own bank (van Dillen?)? Beginning in 1685, when retained earnings had built sufficient capital, the city had the AWB write off both capital and some of the bank's outstanding loans to the city until the AWB's book capital was again near zero, but not negative.

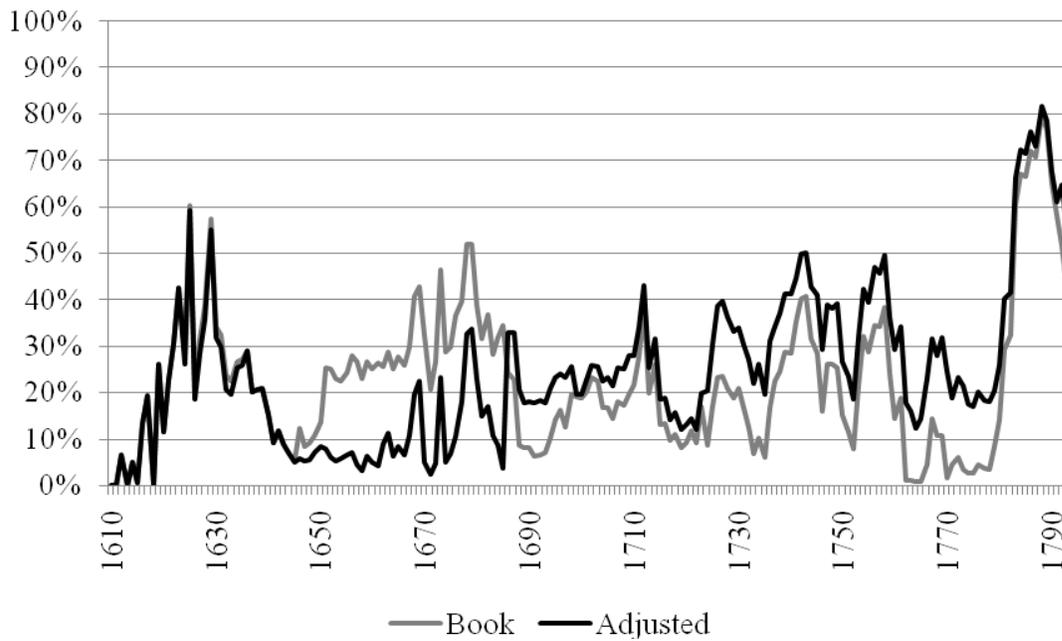
We agree with Willemsen (2009) that the city's taking of metal and creating of balances should be treated as capital extraction rather than as loans. To see the consequences of this interpretation, we calculate adjusted values for capital, loans, and assets. Adjusted capital subtracts the money from capital when the operation occurred instead of when the AWB later wrote-off the loan. Adjusted loans do not add the city as a borrower and do not subsequently write down those loans. Adjusted assets use the adjusted loans series: metal stock plus adjusted loans. Figure A2 compares book and adjusted capital-to-asset ratios. Figure A3 compares book and adjusted loans-to-asset ratios. The adjusted loan-to-asset ratio is sometimes lower than book because municipal loans are ignored but sometimes higher than book because write-offs are also ignored. Table A2 reports the adjusted values.

**Figure A2. AWB Capital-to-Asset Ratios, 1610 to 1795**



Source: Derived by authors from van Dillen (1925, 701-807).

**Figure A3. AWB Loan-to-Asset Ratios, 1610 to 1795**



Source: Derived by authors from van Dillen (1925, 701-807).

The AWB balance sheet, however, does not communicate two important categories of information: gross flows and intra-category activity. The next sections report our efforts to reconstruct gross flows between bank accounts and the other balance sheet categories (see Figure A1).

## **II. The Specie Kamer**

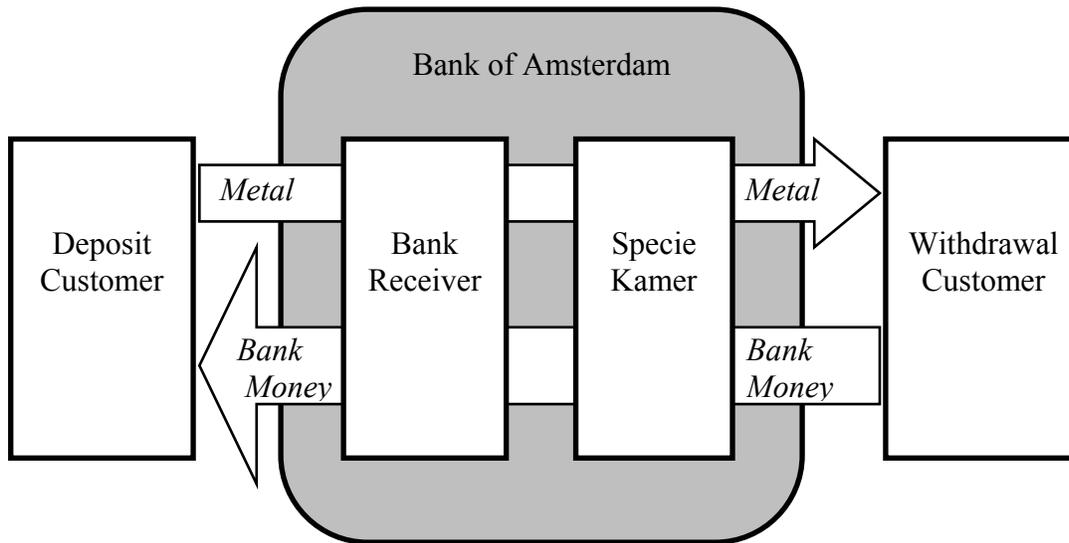
To account for the creation and destruction of bank guilders, the AWB used a master account called the Specie Kamer (or Kammer or Camer) that translates as specie room. Specie Kamer transactions are the top row of Figure A1: deposits and withdrawals (account-metal), VOC and some Amsterdam loans (account-loan), VOC interest payments and some AWB expense payments (account-capital). The bulk of this paper's evidential contribution has involved using the Specie Kamer to reconstruct these transactions. This section details how we did this and what we found.

The Bank of Amsterdam organized its books by half-year increments: February through July, August through January. By the 1700s, the bank needed 3,000 pages to record each half-year of bank activity. The amount of information in the ledgers is staggering. Fortunately for our purposes, the Specie Kamer master accounts are only a few pages per ledger.

### *Receivers*

The bank used two sets of accounts to represent itself. When customers brought a deposit to the bank, the bank usually debited an account in the name of the employee who received the metal. Most years, the bank had two or three such receivers, and this system began in the 1620s. When metal left, the Bank of Amsterdam credited the Specie Kamer. As a result, the combination of receiver debits and the specie room credits gives the changes in the amount of bank money. Figure A4 offers a schematic of the flow of metal and bank money through the bank. Table A3 lists the 74 ledgers and 812 folios used in this study. All ledgers are stored at the Amsterdam Municipal Archives, and the archive retains dissemination rights over the images. The folios were digitally photographed and then encoded.

**Figure A4. Standard Metal Flow through the Bank of Amsterdam**



Here is an example of how the deposit process worked. On 23 May 1687, Arthur Woodward received metal worth 480 bank guilders from Samuel Cohen (5077/109, f.1407). Cohen's account was credited and Woodward's account was debited. The ledger does not report what Cohen deposited, but it was likely a sack (a standard unit for bulk coins) of 200 silver *Dukaat* coins at 2.4 guilders each. If so, then Cohen also should have received a receipt granting the option to buy 200 *Dukaats* from the AWB for 480 bank guilders. We say should because the account ledgers never mention receipts. Two weeks later, on June 6, Woodward transferred 46,800 guilders in metal to the Specie Kamer: Woodward's account was credited (5077/109, f. 1445) and the Specie Kamer debited (5077/109, f. 1431).

#### *Non-Metallic Guilder Creation*

Some guilder creation, however, did not involve incoming metal, and the AWB recorded these directly in the Specie Kamer account and bypassing the receivers. For example, when the VOC borrowed money from the AWB, the VOC's account was credited and the Specie Kamer was debited. To create our borrowing and repayment series, we separate account loans from deposits and repayments from withdrawals.

For some years, extant AWB records tell exact loan creation, repayment and interest payments (AMA 5077/1311 through 1323), so we found the matching transactions. For other years, van Dillen (1925, 979-84) provides total VOC borrowing, repayment and interest, so the matching transactions can be readily found, for the transactions were labeled VOC, and borrowing occurred in 100,000 guilder increments, with the rare exception of a 50,000 increment. Repayments are similarly named and carry the correct amounts for interest.

For the remaining years (1671 through 1675 and 1683 through 1684), the challenge is accounting for loans when we have only year start and year end debt levels. For these years, we have looked for 1) large, round VOC debits and 2) offsetting VOC credits that include the correct interest that 3) combine to leave the correct debt outstanding. Table A4 reports the loans we have identified. The interest rate was a consistent 4 percent except for anticipations in the mid-1670s (de Korte 1984, 66), and the internal rates of return reflect that rate. Finally, we note that the ledger for August 1684 to January 1685 is missing and detailed summaries are missing, so we know nothing about that period except that 400,000 guilders in principal was retired.

Occasionally, the City of Amsterdam also created accounts without depositing metal. As with the VOC, the AWB credited the City of Amsterdam by debiting the Specie Kamer. These transactions are detailed in the bank's balance book records (AMA 5077/1311 through 1323), so we can separate them from metal transactions. Table A5 lists the municipal transactions that changed the supply of guilder (account transactions). Table A5 also lists when the city moved metal in or out of the bank but did not change the guilder money supply (metal transactions). Combining these two transaction types gives the full accounting of the city's extraction of capital from the bank.

### *Bullion*

After removing 1) loans and 2) transfers from receivers, the debit side of the Specie Kamer still contains some direct deposits that avoid the receivers. We lack a contemporaneous description of why some deposits were processed through receivers while others were not, but we think that bullion was directly deposited into the Specie Kamer while coins went through the receivers. To begin, the use of receiver accounting begins in the 1620s, so the distinction predates receipts or the agio. Next, the direct deposits are far more likely to involve a remainder less than a guilder, and even less than a stuiver (1/20th of a guilder). In contrast, receivers see far more large

round deposits. Table A6 measures this dramatic difference through the percent of deposit transactions by depository channel that fall into large round values or into odd values. Bullion tends towards odd values because it is valued by weight and fineness, so a piece of bullion would rarely hit exactly a round guilder value. In contrast, official coins carried assigned values denominated in stuivers: 0.05 guilder increments and almost all in 0.1 increments (Menno S. Polak, *Historiografie en Economie van de "Muntchaos," De Muntproductie van de Republiek 1606-1795, Deel I* (1998), NEHA, Amsterdam, pp. 67-101). The standard bulk unit for coins was a sack of 200, so round guilder values are common. Multiple sacks produce large values round to 100 guilders or even 1,000 guilders.

In practice, the difference looks like this. On July 20, 1688, Samuel Cohen made two deposits that were both credited to the same account (5077/113 f. 1491). With the receiver Arthur Woodward, Cohen deposited 2,400 guilders that could easily have been 4 sacks of silver *rijders* (a standard trade coin) at the ordinance value of 3 guilders per coin (5077/113 f. 1517). Through the Specie Kamer, Cohen deposited 6,873.25 guilders (5077/113 f. 1484). That sum is difficult to reach using standard coins if for no other reason than almost all Dutch coins were priced in even stuivers (0.1 increments). More importantly, we think the bullion-coin divide explains why Cohen made two deposits on the same day, for the pattern can be found on other days. For example, six days earlier, Cohen had deposited 11,073.075 guilders in the Specie Kamer and 3,675 guilders through a receiver (5077/131, ff. 1484, 1517).

Our interpretation has other support. In April and May 1668, the Specie Kamer debits surged, and our theory suggests that this is a period of open market purchases. The AWB's mint orders survive for that year, and simultaneous with the purchases, the bank sent large quantities of silver bullion (480,003 guilders worth) to the various mints from 27 April to 30 May (5077/1313). Table A7 reports the guilder value sent to each mint.

Unfortunately for our purposes, the AWB did not separate metal outflows into different accounts, so we use odd values as a proxy for bullion. While not perfect, a sort by odd-value versus round-value seems to reasonably mirror long-term behavior on the deposit side as seen in Figures X and Y. Also, we know that the great run of June 1672 was not an open market operation. In that month, round values withdrawals (our proxy for coin) totaled 2.5 million guilders while odd-values withdrawals (our proxy for bullion) totaled 0.3 million guilders. The monthly flow of these series is reported in Table A8.

### III. Fee Ratios

Having reconstructed withdrawals for our sample period, we calculated an average fee per year by dividing fee revenue by total withdrawals. Table A9 reports the numbers in ratio of fee revenue over metal outflows.

Fee revenue had to be constructed for the years 1666 to 1684, for the AWB reported total revenue. We adjusted revenue for the AWB's practice of counting interest due from the VOC as revenue and subsequently not counting the actual interest payments. Next we removed interest payments from the VOC (by Specie Kamer account) and from the Province of Holland (by metal) to get a remainder to proxy "withdrawal fee" revenue. The proxy overstates actual withdrawal fee revenue, for it also includes other minor fees like overdraft charges. We do not report revenue for the fiscal year 1673 because the bank replaced its regular revenue and expenses with a single 67,247 write down caused by the re-pricing of Russian coins held by the bank (van Dillen 1925: 746). 1677, 1682 and 1684 lack complete withdrawal information because of missing ledgers. The 1679 withdrawal numbers are low (fee ratio high) because we lack one Specie Kamer folio for that year.

1683 is the only year during the receipt regime for which we have revenue and withdrawals. The ratio is 0.67 percent, but it is a poor proxy for withdrawal fees. Under the new regime, one paid a receipt fee to rollover the option, so no metal need leave the bank. Also the bank began charging a transfer fee of 0.025 percent (van Dillen 1934: 84). We cannot separate these different revenue sources, so we can only state that fee revenue dropped to a low rate in the year receipts were adopted.

### IV. VOC

Table A10 considers the AWB as a creditor to the VOC in two ways: levels and flows. Column 1 reports the amount the VOC owed to the AWB in *bank* guilders. We calculate this amount using the bank's records. The VOC records do not identify creditors. Column 2 reports the level of the VOC's total debt in *current* guilders. The total debt is comprised of obligations of the company in general, obligations of each chamber, anticipations, bills of exchange, and mis-

cellaneous creditors. Column 3 gives the AWB's share of the total and assumes an agio of 4.5 percent.

While some years find the VOC owing 10 to 20 percent of its debt to the AWB, 15 out of 36 fiscal years closed with the company owing nothing to the bank. Levels suggest that in the VOC relied on the AWB as a substantial multi-year lender in and near the 1680s. Otherwise, the AWB was a long-term lender of little consequence.

To see the short-term credit story, we have reconstructed the amount the VOC borrowed from the AWB during each fiscal year (column 4). We do not report repayment, for we already know that often this debt was repaid within the year. Instead, we wonder how the VOC was using the AWB to facilitate operations during a fiscal year. Unfortunately, the VOC records do not tell us intra-year borrowing, so we cannot calculate the AWB's share of all short-term lending to the VOC.

We do know, however, some general measures of VOC activity, so we instead see what correlates with VOC borrowing from the AWB. Our approach is descriptive and seeks only the gentlest of inferences regarding why the VOC borrowed from the AWB. As a dependent variable, we have the amount of VOC borrowing from the AWB per fiscal year in bank guilders. For explanatory variables, we know the following in current guilders:

Two activities potentially creating demand for loans:

1. The total amount spent by the VOC in the Netherlands outfitting ships, paying interest, etc.
2. The amount of cash dividends paid out by the company to shareholders.

One activity potentially reducing the demand for loans

3. The total amount collected by the VOC from selling goods.

And a few VOC balance sheet items (levels) at the **start** of each fiscal year that might affect demand for AWB loans in the forthcoming year:

4. The trade good inventory
5. The cash and bank balances
6. Trade credits due to the VOC
7. The total external debt

We regressed AWB lending on these seven variables using OLS with no modifications, and the result is in the paper as Table X. Expenditures strongly and positively correlate with borrowing. They suggest a derived demand for AWB loans of 25 percent of total expenditures. In contrast, Information about that year's sales revenue lacks any explanatory power. These results agree with the idea that the VOC was borrowing to outfit ships before the year's fleet returned from Asia.

Dividends appear of occasional consequence, and we cannot sort out why some dividends correlate with AWB borrowing while others do not.

Of the four start-of-year levels, the three assets (substitutes to AWB loans) do have negative coefficients. While not statistically significant, the inventor and credit due levels suggest notable effects. Starting cash appears of little import. Finally, the level of VOC debt at the start of a fiscal year gives little information regarding AWB loans.

In total, we feel that comparing AWB loan amounts to yearly VOC expenditures (Column 5) gets at the heart of the AWB-VOC credit relationship. While that share (Column 6) did vary, AWB loans became a routine, and often substantial, part of financing yearly ship outfitting.

## **V. Interpolation of the agio**

The agio series was interpolated using a time series on the London price of a bill of exchange payable in Amsterdam (McCusker 1978, Table 2.8), quoted as bank schillings (i.e., 0.3 guilders) per pound sterling. The bill price series contains 179 monthly observations over the sample period, including 77 months for which there is no corresponding agio observation. A Kalman filter routine was used to fit a 3-month, bivariate VAR by maximum likelihood to all available observations on the agio and on the bill price. Interpolated values of the agio are the values returned by the Kalman smoother at the ML estimates.

The accuracy of this method was tested by simulations, in which a random selection of agio observations (excluding the 1672 and 1693 outlier periods) were removed from the sample and then estimated using the interpolation procedure described above. The standard error of the smoothed estimates of the agio ranges from about 22 basis points over the holdout sample (with a 5 percent probability of observations being allocated to holdout sample) to 35 basis points

(with a 50 percent probability). These are smaller than sample standard deviation of the agio series (about 50 basis points; see Table 3), suggesting that the interpolation procedure is of value in estimating missing values of the agio.

**Table A1. AWB Balance Sheet, 1666 to 1703, in Bank Guilders<sup>1</sup>**

End of January	Total Balance	Metal Stock	VOC Principal	VOC Interest Due	Amsterdam Principal	Holland <sup>2</sup>	Misc. <sup>3</sup>	Account Balances	Capital
1666	10,057,240	7,454,756	300,000	1,925	2,072,898	224,662	0	8,411,238	1,646,002
1667	9,808,032	6,904,522	600,000	5,950	2,072,898	224,662	0	8,137,198	1,670,834
1668	7,916,122	4,700,428	900,000	8,311 <sup>4</sup>	2,072,898	224,662	9,823	6,202,978	1,713,144
1669	7,851,084	4,488,911	1,000,000	18,333	2,072,898	224,662	46,281	6,078,661	1,772,423
1670	7,166,504	4,841,334	0	0	2,072,898	224,662	27,610	5,367,018	1,799,486
1671	11,160,451	8,862,891	0	0	2,072,898	224,662	0	9,355,574	1,804,877
1672	9,056,487	6,654,277	100,000	0	2,072,898	224,662	4,649	7,210,433	1,846,054
1673	6,852,616	3,664,117	0	0	2,072,898	224,662	890,940	4,933,701	1,918,915
1674	8,366,142	5,976,295	0	0	2,072,898	226,830	90,119	6,514,474	1,851,668
1675	8,451,723	5,944,943	200,000	0	2,072,898	226,830	7,052	6,587,691	1,864,032
1676	7,071,631 <sup>5</sup>	4,471,902	300,000	0	2,072,898	226,830	0	5,174,297	1,897,334
1677	7,862,941	4,747,706	800,000	15,507	2,072,898	226,830	0	5,924,194	1,938,747
1678	7,226,068	3,475,326	1,400,000	51,013	2,072,898	226,830	0	5,229,008	1,997,060
1679	7,545,572	3,632,511	1,600,000	13,333	2,072,898	226,830	0	5,488,900	2,056,672
1680	10,069,553	6,156,491	1,600,000	13,333	2,072,898	226,830	0	7,950,340	2,119,213
1681	10,444,657	7,136,595	1,000,000	8,333	2,072,898	226,830	0	8,277,109	2,167,548
1682	8,741,257	5,536,528	900,000	5,000	2,072,898	226,830	0	6,510,142	2,231,115
1683	10,567,596	7,595,133	400,000	3,333	2,342,299	226,830	0	8,295,978	2,271,618
1684	9,990,534	6,822,321	400,000	5,199	2,536,184	226,830	0	7,695,285	2,295,249
1685	9,300,020	6,096,968	0	0	2,976,222	226,830	0	6,959,229	2,340,791
1686	9,860,991	7,472,301	1,100,000	6,124	1,055,735	226,830	0	9,813,776	47,215
1687	10,237,827	7,913,428	1,300,000	29,604	767,965	226,830	0	10,175,964	61,863
1688	10,884,061	9,946,553	0	0	710,243	227,264	0	10,752,029	132,032
1689	12,864,189	11,831,444	0	0	805,481	227,264	0	12,714,692	149,497
1690	12,775,203	11,742,458	0	0	805,481	227,264	0	12,604,282	170,921
1691	13,569,830	12,708,006	0	0	634,560	227,264	0	13,557,117	12,713
1692	13,183,611	12,321,787	0	0	634,560	227,264	0	13,181,990	1,620
1693	13,559,192	12,602,130	0	0	729,798	227,264	0	13,524,659	34,533
1694	11,535,761	10,377,152	0	0	931,345	227,264	0	11,479,354	56,407
1695	12,108,018	10,405,194	400,000	0	1,075,560	227,264	0	12,013,638	94,380
1696	10,332,717	8,648,941	0	0	1,456,512	227,264	0	10,207,122	125,595
1697	10,412,947	9,110,123	0	0	1,075,560	227,264	0	10,263,048	149,899
1698	15,386,685	12,383,861	1,500,000	0	1,275,560	227,264	0	15,233,928	152,757
1699	16,919,060	13,716,236	600,000	0	2,375,560	227,264	0	16,750,540	168,520
1700	16,468,096	13,365,272	500,000	0	2,375,560	227,264	0	16,284,849	183,247
1701	15,040,586	12,037,762	800,000	0	1,975,560	227,264	0	14,830,152	210,434
1702	15,044,384	11,541,561	1,300,000	0	1,975,560	227,264	0	14,782,959	261,425
1703	12,908,349	10,005,525	700,000	0	1,975,560	227,264	0	12,578,043	330,306

Source is authors' adjustment of van Dillen (1925, 741-762)

Notes for Table A1:

1. Holland's debt is in current guilders.
2. In The 1666 total comprises a loan of 132,000 at 4 percent, one year's interest on that sum (5,280), a loan of 84,836 at 4 percent, and 9 month's interest on that sum (2,546). See AMA 5077/1311, folio 4. In 1674, Holland's debt was increased by 2,168 because of missed interest payments in 1673 (AMA 5077/1315, folio 4). An additional 434 in interest is considered due from Holland starting in 1688 (5077/1322, folio 16).
3. Miscellaneous includes negative balances of assayers, mint masters, an emergency loan in 1672, and other unspecified claims. All miscellaneous lending ends in 1676.
4. Miscellaneous includes negative balances of assayers, mint masters, an emergency loan in 1672, and other unspecified claims. All miscellaneous lending ends in 1676.
5. The 1676 metal stock and capital have been reduced by 30,000 each per a write-down not booked until 1677 (van Dillen 1925: 747-8; AMA 5077/1315, folios 1-2).

**Table A2. Adjusted Capital and Adjusted Loans, Bank Guilders, 1610 to 1795**

Year	Adjusted Capital	Adjusted Loans	Year	Adjusted Capital	Adjusted Loans	Year	Adjusted Capital	Adjusted Loans
1610	0	0	1649	1,048,270	668,007	1688	-578,211	2,568,057
1611	6,783	0	1650	780,642	952,332	1689	-655,984	2,568,056
1612	18,009	71,361	1651	-171,727	551,353	1690	-634,560	2,568,056
1613	26,276	0	1652	-287,170	431,214	1691	-621,847	2,738,978
1614	30,277	37,546	1653	-426,594	413,160	1692	-621,846	2,738,979
1615	30,277	6,000	1654	-408,384	473,593	1693	-696,265	2,737,978
1616	45,309	98,604	1655	-371,856	503,510	1694	-874,938	2,738,978
1617	89,912	272,739	1656	-335,762	448,308	1695	-981,180	3,138,978
1618	118,020	0	1657	-324,738	261,122	1696	-1,330,917	2,738,978
1619	138,501	493,198	1658	-320,393	224,661	1697	-925,661	2,738,978
1620	165,613	239,283	1659	-308,098	424,941	1698	-1,122,803	4,238,978
1621	208,390	578,628	1660	-393,040	355,994	1699	-2,207,040	3,338,978
1622	252,029	879,476	1661	-370,585	274,661	1700	-2,192,313	3,238,978
1623	282,527	1,101,707	1662	-368,928	771,411	1701	-1,765,126	3,538,978
1624	146,052	674,635	1663	-489,333	947,770	1702	-1,714,135	4,038,977
1625	193,328	1,351,161	1664	-461,929	526,712	1703	-1,645,254	3,438,978
1626	140,151	699,041	1665	-430,877	632,448	1704	-1,260,493	2,738,978
1627	190,926	1,030,963	1666	-426,896	529,586	1705	-1,012,999	3,038,978
1628	233,265	1,266,306	1667	-402,064	830,612	1706	-965,929	2,738,978
1629	279,496	1,925,131	1668	-359,754	1,142,796	1707	-928,233	2,938,978
1630	385,683	1,446,393	1669	-300,475	1,289,275	1708	-914,576	2,738,978
1631	447,857	1,255,162	1670	-273,412	252,272	1709	-897,183	2,738,977
1632	503,164	858,130	1671	-268,021	224,662	1710	-873,219	3,638,978
1633	542,520	947,854	1672	-226,844	329,312	1711	-822,479	4,038,978
1634	657,387	1,178,526	1673	-153,983	1,115,601	1712	-856,337	5,138,978
1635	748,564	1,192,794	1674	-221,230	316,949	1713	-754,899	3,438,978
1636	907,639	1,413,671	1675	-208,866	433,882	1714	-694,545	3,938,978
1637	973,853	1,338,799	1676	-145,564	526,831	1715	-650,803	2,738,979
1638	1,028,590	1,365,735	1677	-134,151	1,042,337	1716	-598,560	2,738,978
1639	1,087,216	1,443,943	1678	-75,838	1,677,844	1717	-560,224	2,738,979
1640	1,134,087	1,385,481	1679	-16,226	1,840,163	1718	-490,558	2,738,978
1641	1,137,482	837,277	1680	46,315	1,840,164	1719	-434,547	2,738,978
1642	1,139,312	727,691	1681	94,650	1,235,164	1720	-354,039	2,738,978
1643	1,164,660	678,344	1682	158,217	1,131,831	1721	-278,386	4,438,978
1644	1,197,840	590,719	1683	198,720	899,565	1722	-114,700	3,538,978
1645	1,154,780	601,739	1684	-240,935	632,029	1723	15,259	5,338,978
1646	644,395	466,382	1685	-635,431	226,830	1724	120,000	6,523,561
1647	1,006,185	468,281	1686	-1,008,520	3,673,747	1725	149,700	7,723,561
1648	1,017,687	498,568	1687	-706,102	3,897,226	1726	149,202	7,923,560

1727	127,595	7,723,561	1768	207,653	5,923,561
1728	252,137	7,623,560	1769	338,937	5,523,560
1729	357,168	7,723,561	1770	447,771	4,323,560
Jan.	Adjusted Capital	Adjusted Loans	Jan.	Adjusted Capital	Adjusted Loans
1730	75,473	8,323,560	1771	-512,590	4,323,561
1731	95,267	7,623,560	1772	-463,470	4,323,561
1732	153,113	6,623,560	1773	-127,640	4,323,560
1733	115,306	5,523,561	1774	-164,582	4,323,560
1734	136,117	6,023,560	1775	-253,028	4,323,561
1735	138,283	5,523,560	1776	-433,513	4,423,560
1736	48,386	7,423,560	1777	-422,304	4,323,560
1737	134,486	9,123,560	1778	-365,263	4,323,560
1738	152,524	9,123,560	1779	-416,127	5,623,561
1739	181,201	9,623,561	1780	-360,838	6,923,560
1740	315,011	9,423,560	1781	-460,114	9,123,561
1741	-335,930	10,923,561	1782	-531,507	10,082,619
1742	-261,335	11,023,561	1783	-603,214	15,339,227
1743	-437,044	11,423,560	1784	-618,238	15,586,728
1744	-226,955	9,323,561	1785	-631,521	16,498,133
1745	-443,367	8,223,561	1786	-577,466	17,052,037
1746	-563,412	6,323,560	1787	-2,141,054	15,274,442
1747	-886,538	6,823,560	1788	-2,115,706	16,639,312
1748	-1,033,812	6,823,560	1789	-2,083,569	17,666,574
1749	-1,147,236	5,923,560	1790	-2,088,377	16,002,090
1750	-1,247,600	5,523,560	1791	-2,065,833	15,256,351
1751	-1,249,450	4,823,560	1792	68,696	15,408,846
1752	-1,309,966	4,323,560	1793	-27,955	15,426,561
1753	-1,107,270	6,973,560	1794	-38,358	15,573,561
1754	-988,555	8,373,560	1795	-193,672	15,510,418
1755	-839,638	8,123,561			
1756	-676,087	8,023,560			
1757	-506,876	8,823,560			
1758	-311,706	9,803,560			
1759	-115,639	8,603,560			
1760	131,221	6,713,560			
1761	-18,765	7,023,560			
1762	116,261	4,323,560			
1763	175,405	4,323,560			
1764	119,655	4,323,560			
1765	154,629	4,323,560			
1766	302,442	4,823,560			
1767	401,300	6,423,560			

Source: Authors' calculation using Van Dillen (1925: 701-807) and AMA 5077/1311 through 1323

**Table A3. AWB Ledgers and Folios**

By Half-Year Periods: a=February to July, b=August to January

Date	Ledger	Folios: Specie Kamer in Bold, Receiver Folios in Regular (kept in sequence by receiver)									
1666a	5077/62	<b>147</b>	<b>1174</b>	1391	149	151					
1666b	5077/63	<b>1054</b>	<b>1233</b>	1050	1052	1260					
1667a	5077/64	<b>982</b>	<b>1149</b>	<b>1249</b>	<b>1387</b>	984	986	988			
1667b	5077/65	<b>982</b>	<b>1088</b>	<b>1144</b>	<b>1263</b>	984	986	988			
1668a	5077/66	<b>1006</b> 1012	<b>1082</b>	<b>1179</b>	<b>1238</b>	<b>1252</b>	<b>1276</b>	<b>1397</b>	<b>1528</b>	1008	1010
1668b	5077/67	<b>1010</b>	<b>1154</b>	<b>1474</b>	1012	1018	1020				
1669a	5077/68	<b>1010</b>	<b>1203</b>	<b>1479</b>	1012	1014	1016				
1669b	5077/69	<b>1010</b>	<b>1314</b>	1012	1014	1330	1016	1353			
1670a	5077/70	<b>1008</b>	<b>1177</b>	<b>1220</b>	1010	1328	1012	1129	1240	1014	1347
1670b	5077/71	<b>1008</b> 1172	<b>1060</b> 1416	<b>1114</b>	<b>1262</b>	1010	1250	1420	1012	1348	1014
1671a	5077/72	<b>90</b> 1038	<b>1273</b> 1207	<b>1375</b>	<b>1450</b>	<b>1494</b>	1034	1077	1140	1036	1120
1671b	5077/73	<b>1028</b>	<b>1142</b>	<b>1501</b>	1030	1032	1034				
1672a	5077/74	<b>990</b> <b>1496</b>	<b>1415</b> <b>1501</b>	<b>1433</b> 1076	<b>1439</b> 1078	<b>1449</b> 1080	<b>1455</b>	<b>1461</b>	<b>1465</b>	<b>1478</b>	<b>1488</b>
1672b	5077/75	<b>1044</b>	<b>1047</b>	1046	1220	1048	1050				
1673a	Missing										
1673b	5077/76	<b>1020</b> 722	<b>1082</b> 1062	<b>1158</b> 1116	1022	1024	1026	1032	1062	258	298
1674a	5077/77	<b>878</b>	<b>1209</b>	<b>1303</b>	880	882	884				
1674b	5077/78	<b>910</b>	<b>1114</b>	<b>1341</b>	<b>1446</b>	912	914	916			
1675a	5077/79	<b>952</b>	<b>1282</b>	<b>1467</b>	954	956	958				
1675b	5077/80	<b>974</b>	<b>1217</b>	976	978	980					

1676a	5077/81	<b>1016</b>	1018	1020	1022							
1676b	5077/82	<b>1042</b>	1044	1046	1048							
1677a	Missing											
1677b	5077/83	<b>1044</b>	<b>1494</b>	1046	1048	1050						
1678a	5077/84	<b>1078</b>	<b>1452</b>	1080	1082	1084						
1678b	5077/85	<b>1058</b>	1060	1062	1064							
1679a	5077/86	<b>1021</b>	1022	1023	1024							
1679b	5077/87	<b>1008</b>	<b>1332</b>	<b>1421</b>	1009	1010	1011					
1680a	5077/88	<b>978</b>	<b>1024</b>	<b>1382</b>	979	980	981					
1680b	5077/89	<b>1006</b>	979	980	981							
1681a	5077/90	<b>982</b>	979	980	981							
1681b	5077/91	<b>982</b>	979	980	981							
1682a	5077/92	<b>981</b>	979	1390	980	1396	949					
1682b	Missing											
1683a	5077/94	<b>990</b>	<b>1406</b>	<b>1564</b>	988	1505	989	1052	1296	1351	1514	
1683b	5077/96	<b>990</b>	<b>1292</b>	<b>1337</b>	<b>1422</b>	<b>1519</b>	988	994	989	1286	1463	
1684a	5077/98	<b>990</b> 1567	<b>1277</b> 989	<b>1317</b> 1407	<b>1360</b> 1512	<b>1383</b> 1573	<b>1411</b>	<b>1484</b>	<b>1585</b>	988	1518	
1684b	Missing											
1685a	5077/101	<b>990</b> 1453	<b>1274</b> 989	<b>1300</b> 1334	<b>1344</b> 1427	<b>1402</b> 1484	<b>1450</b>	<b>1500</b>	<b>1533</b>	988	1330	
1685b	5077/103	<b>990</b> 1296 1508	<b>1299</b> 1317 1531	<b>1335</b> 1459	<b>1344</b> 1503	<b>1349</b> 1532	<b>1365</b> 989	<b>1378</b> 1300	<b>1399</b> 1321	<b>1462</b> 1411	988 1470	
1686a	5077/105	<b>990</b> 1492	<b>1280</b> 989	<b>1300</b> 1313	<b>1334</b> 1408	<b>1390</b> 1471	<b>1451</b> 1494	<b>1491</b>	988	1275	1462	
1686b	5077/107	<b>990</b> 1392	<b>1283</b> 989	<b>1319</b> 1284	<b>1378</b> 1310	<b>1437</b> 1335	<b>1476</b> 1358	988 1369	1303 1402	1339 1470	1366 1492	

1687a	5077/109	<b>990</b> 1413 1477	<b>1297</b> 1465 1497	<b>1354</b> 1491	<b>1431</b> 989	<b>1496</b> 1283	988 1303	1291 1329	1322 1380	1353 1407	1376 1445
1687b	5077/111	<b>990</b> 1315 1395	<b>1312</b> 1347 1413	<b>1377</b> 1383	<b>1462</b> 1412	<b>1482</b> 989	<b>1498</b> 1289	<b>1515</b> 1301	<b>1527</b> 1321	988 1345	1290 1371
1688a	5077/113	<b>990</b> 1511	<b>1299</b> 989	<b>1326</b> 1379	<b>1380</b> 1432	<b>1429</b> 1464	<b>1484</b> 1489	<b>1537</b> 1517	988 1534	1378	1450
1688b	5077/115	<b>990</b> 1393 1495	<b>1314</b> 1420	<b>1351</b> 989	<b>1403</b> 1306	<b>1455</b> 1338	<b>1487</b> 1366	<b>1514</b> 1388	<b>1540</b> 1405	988 1416	1354 1443
1689a	5077/117	<b>1171</b> 1503	<b>1423</b> 1564	<b>1450</b> 1624	<b>1461</b>	<b>1493</b>	<b>1552</b>	<b>1596</b>	1181	1176	1427
1689b	5077/119	<b>1171</b> 1421	<b>1429</b> 1439	<b>1476</b> 1471	<b>1533</b> 1519	<b>1581</b> 1532	<b>1616</b>	<b>1640</b>	<b>1676</b>	1181	1176
1690a	5077/121	<b>1171</b> 1176	<b>1419</b> 1643	<b>1440</b>	<b>1463</b>	<b>1502</b>	<b>1542</b>	<b>1591</b>	<b>1624</b>	<b>1664</b>	1181
1690b	5077/123	<b>1171</b> 1176	<b>1421</b> 1454	<b>1439</b> 1527	<b>1463</b> 1562	<b>1499</b> 1581	<b>1540</b> 1181	<b>1575</b> 1259	<b>1609</b> 1555	<b>1651</b> 1586	<b>1695</b>
1691a	5077/124	<b>1171</b> <b>1715</b>	<b>1427</b> 1176	<b>1440</b> 1632	<b>1464</b> 1692	<b>1485</b> 1181	<b>1511</b> 1603	<b>1549</b>	<b>1573</b>	<b>1622</b>	<b>1675</b>
1691b	5077/126	<b>1171</b> 1466	<b>1448</b> 1547	<b>1478</b> 1676	<b>1521</b> 1181	<b>1574</b> 1487	<b>1620</b> 1563	<b>1668</b> 1657	<b>1709</b>	<b>1739</b>	1176
1692a	5077/128	<b>1171</b> 1176	<b>1461</b> 1581	<b>1490</b> 1181	<b>1512</b> 1492	<b>1547</b> 1632	<b>1583</b> 1719	<b>1623</b>	<b>1667</b>	<b>1698</b>	<b>1728</b>
1692b	5077/130	<b>1171</b> 1488	<b>1467</b> 1635	<b>1498</b> 1683	<b>1545</b> 1758	<b>1586</b> 1181	<b>1631</b> 1569	<b>1675</b> 1622	<b>1734</b> 1674	<b>1766</b> 1785	1176
1693a	5077/132	<b>1171</b> <b>1675</b> 1756	<b>1486</b> <b>1705</b>	<b>1504</b> <b>1728</b>	<b>1532</b> <b>1772</b>	<b>1559</b> <b>1793</b>	<b>1585</b> 1176	<b>1619</b> 1616	<b>1639</b> 1750	<b>1654</b> 1181	<b>1673</b> 1609
1693b	5077/134	<b>1171</b> 1655	<b>1444</b> 1181	<b>1465</b> 1562	<b>1501</b> 1637	<b>1527</b>	<b>1576</b>	<b>1640</b>	<b>1686</b>	1176	1554
1694a	5077/136	<b>1171</b> 1176	<b>1443</b> 1689	<b>1464</b> 1181	<b>1505</b> 1705	<b>1540</b>	<b>1585</b>	<b>1628</b>	<b>1687</b>	<b>1732</b>	<b>1776</b>
1694b	5077/138	<b>1171</b>	<b>1447</b>	<b>1481</b>	<b>1530</b>	<b>1601</b>	<b>1653</b>	<b>1721</b>	1176	1181	1182

1695a	5077/140	<b>1171</b> 1181	<b>1451</b>	<b>1475</b>	<b>1517</b>	<b>1564</b>	<b>1610</b>	<b>1679</b>	<b>1760</b>	<b>1799</b>	1176
1695b	5077/142	<b>1171</b> 1612	<b>1454</b> 1181	<b>1487</b>	<b>1535</b>	<b>1599</b>	<b>1673</b>	<b>1747</b>	<b>1797</b>	1176	1562
1696a	5077/143	<b>1171</b> 1515	<b>1465</b> 1598	<b>1501</b> 1745	<b>1548</b> 1181	<b>1607</b> 1533	<b>1662</b> 1695	<b>1720</b>	<b>1765</b>	<b>1813</b>	1176
1696b	5077/145	<b>1171</b> 1181	<b>1478</b> 1588	<b>1512</b> 1699	<b>1581</b>	<b>1645</b>	<b>1730</b>	<b>1829</b>	1176	1720	1833
1697a	5077/146	<b>1171</b> 1674	<b>1481</b> 1725	<b>1536</b> 1784	<b>1589</b> 1181	<b>1645</b> 1469	<b>1704</b> 1573	<b>1764</b> 1650	1176 1744	1482	1590
1697b	Missing										
1698a	5077/148	<b>1171</b> 1594	<b>1405</b> 1735	<b>1523</b>	<b>1593</b>	<b>1688</b>	<b>1768</b>	1176	1664	1784	1181
1698b	5077/150	<b>1171</b> 1761	<b>1476</b> 1860	<b>1556</b> 1181	<b>1676</b> 1487	<b>1815</b> 1577	1176 1693	1505 1770	1560 1902	1619	1666
1699a	5077/152	<b>1171</b> 1595	<b>1504</b> 1674	<b>1533</b> 1785	<b>1596</b> 1849	<b>1663</b> 1181	<b>1744</b> 1541	<b>1802</b> 1645	<b>1842</b> 1812	1176	1516
1699b	5077/154	<b>1171</b> 1655	<b>1484</b> 1730	<b>1537</b> 1843	<b>1595</b> 1181	<b>1689</b> 1478	<b>1807</b> 1502	1176 1576	1513 1704	1588 1741	1624 1824
1700a	5077/156	<b>1271</b> 1684	<b>1612</b> 1726	<b>1657</b> 1871	<b>1707</b> 1914	<b>1779</b> 1281	<b>1885</b> 1590	<b>1961</b> 1637	1276 1739	1601 1917	1646 1962
1700b	Missing										
1701a	5077/158	<b>1271</b> 1799 1810	<b>1659</b> 1895 1872	<b>1734</b> 1967 1946	<b>1829</b> 2020 2003	<b>1939</b> 1281	<b>2002</b> 1607	1276 1622	1597 1643	1700 1665	1743 1719
1701b	5077/160	<b>1271</b> 1624	<b>1629</b> 1712	<b>1670</b> 1801	<b>1737</b> 1932	<b>1805</b> 1281	<b>1878</b> 1639	<b>2011</b> 1733	1276 1859	1601 1960	1609
1702a	5077/162	<b>1271</b> 1928	<b>1627</b> 1281	<b>1691</b> 1630	<b>1779</b> 1685	<b>1848</b> 1765	<b>1935</b> 1847	1276 1983	1647	1704	1825
1702b	5077/164	<b>1371</b>	<b>1732</b>	<b>1785</b>	<b>1866</b>	<b>1934</b>	<b>2003</b>	1376	1916	1381	

**Table A4. Deduced VOC Loans**

Loans		Repayments		Internal Rate of Return	
Date	Amount	Date	Amount		
7-Jul-71	200,000	→ 10-Sep-71	201,446.20	4.06%	
17-Jul-71	400,000	→ 9-Sep-71	402,410.38	4.07%	
24-Jul-71	300,000	→ 11-Sep-71	301,643.75	4.08%	
4-Aug-71	200,000	→ 610576	200,861.50	4.03%	
9-Jan-72	100,000	→	9-Mar-72	200,800.00	3.24%
8-Feb-72	100,000				
13-Nov-74	100,000	→	4-Dec-74	200,942.45	4.10%
13-Nov-74	300,000	→	2-Apr-75	203,777.70	5.79% <sup>1</sup>
10-Jan-75	300,000	→	11-Jan-75	300,000.00	
9-Jul-75	150,000	→	19-Oct-75	654,710.90	3.97%
13-Aug-75	200,000				
28-Aug-75	200,000				
7-Sep-75	100,000				
18-Sep-75	100,000	→	24-Oct-75	401,022.30	4.06%
3-Oct-75	100,000				
4-Oct-75	100,000				
9-Oct-75	100,000				
31-Jan-83	403,333 <sup>2</sup>	→	4/2/83	101,533.33	4.19%
			4/2/83	203,066.65	4.19%
			4/2/83	101,533.33	4.19%
4/16/83	200,000	→	11/25/83	204,644.45	3.80%
5/13/83	100,000	→	11/25/83	102,088.80	3.89%

6/18/83	100,000	→	11/25/83	101,744.35	3.98%
7/14/83	50,000	→	11/25/83	50,727.73	3.96%
7/20/83	50,000	→	11/25/83	50,677.78	3.87%
8/23/83	50,000	→	11/25/83	50,511.10	3.97%
8/31/83	100,000	→	11/25/83	100,944.48	4.01%
10/26/83	100,000	→	12/3/83	100,400.00	3.84%
11/1/83	100,000				
11/9/83	50,000				
11/12/83	100,000				
11/15/83	100,000		→	12/1/83	350,816.65
9/13/83	100,000				
10/5/83	100,000				
10/12/83	100,000				
10/14/83	100,000		→	1/31/84 <sup>3</sup>	405,199.00

Source: Authors' analysis.

#### Notes

1. De Korte (1984: 66) suggests that the VOC offered 6 percent on anticipations in 1674.
2. Uses the bank's record of debt due at the start of fiscal year 1683.
3. Used the bank's record of debt due at the end of fiscal year 1684.

**Table A5. Municipal Capital Extractions and Injections**

Municipal Capital Extractions

Date	Type	Bank Guilders	Current Guilder	Agio Used
5/30/82	Account	20,000.00	20,850.00	4 1/4
14-Jan-83	Metal	249,400.50	260,000.00	4 1/4
10-Feb-83	Metal	143,885.00	150,000.00	4 1/4 <sup>1</sup>
26-Jan-84	Metal	50,000.00	52,125.00	4 1/4 <sup>1</sup>
1-Mar-84	Metal	50,000.00	52,062.50	4 1/8 <sup>1</sup>
2-May-84	Metal	96,154.00	100,000.00	4 <sup>1</sup>
26-Oct-84	Metal	150,000.00	156,187.50	4 1/8 <sup>1</sup>
11-Jan-85	Metal	143,885.00	150,000.00	4 1/4 <sup>1</sup>
14-Feb-85	Metal	120,863.30	126,000.00	4 1/4
13-Jul-85	Metal	47,961.65	50,000.00	4 1/4
28-Jul-85	Metal	47,961.65	50,000.00	4 1/4
28-Aug-85	Metal	95,923.30	100,000.00	4 1/4
15-Nov-85	Metal	47,961.65	50,000.00	4 1/4
7-Dec-85	Metal	59,632.60	62,167.00	4 1/4
19-Feb-87	Metal	57,142.85	60,000.00	5
7-Apr-88	Metal	95,238.10	100,000.00	5
23-Jan-93	Metal	95,238.10	100,000.00	5
4-Jun-93	Metal	142,500.00	150,000.00	5 5/19 <sup>2</sup>
30-Oct-93	Metal	59,047.60	62,000.00	5
25-Feb-94	Metal	48,976.00	51,458.00	5
20-Jul-94	Metal	95,238.00	100,000.00	5
17-Feb-95	Metal	95,238.00	100,000.00	5
8-Nov-95	Metal	95,238.00	100,000.00	5
11-Jan-96	Metal	190,476.00	200,000.00	5
18-Dec-97	Account	100,000.00		
14-Jan-98	Account	100,000.00		
28-Oct-98	Account	100,000.00		
6-Nov-98	Account	200,000.00		
8-Dec-98	Account	200,000.00		
25-Nov-98	Account	300,000.00		
23-Dec-98	Account	300,000.00		
3-Mar-99	Account	100,000.00		
18-Mar-99	Account	100,000.00		
18-Mar-02	Metal	95,522.40	100,000.00	4 11/16

Table A5 Continued

Municipal Capital Injections

Date	Type	Bank Guilder	Current Guilder	Agio
12-Jun-86	Metal	191,847.00	200,000.00	4 1/4
19-Jul-86	Metal	95,923.00	100,000.00	4 1/4
23-Mar-87	Metal	57,142.85	60,000.00	5
26-Aug-87	Metal	28,571.45	30,000.00	5
4-Sep-87	Metal	28,571.45	30,000.00	5
18-Apr-96	Metal	190,476.00	200,000.00	5
1-Sep-96	Metal	190,476.00	200,000.00	5
28-Mar-99	Account	200,000.00		
6-Mar-99	Metal	100,000.00	105,000.00	5
8-Apr-00	Account	400,000.00		

Sources: AMA 5077/1311 through 1323.

Notes:

1. Imputed from bank guilders (5077/1321 f 7) and current guilders (5077/1322 loose insert).
2. Coins removed in sacks worth 600 current booked at 570 bank: likely dreiguilders

**Table A6. Large Value and Odd Value Deposits 1666 to 1703**

	Specie Kamer Direct Debits <sup>1</sup>	Receiver Debits
Total Deposit Transactions	3,686	17,771
Share of Deposits with guilder values that are Large Values: Round 100's	6.1%	48.5%
Share of Deposits with guilder values that are Odd Values:		
With a Partial Guilder	81.6%	7.4%
With Partial Stuiver (1/20 <sup>th</sup> of a guilder)	10.3%	0.5%

Source: Authors' calculation.

Notes

1. Excludes loan transactions, receiver transfers, and expenditures.

**Table A7. AWB Mint Operations, April and May 1668**

Guilder Value of Silver Bullion Sent to Various Mint					
Mint	27-Apr	1-May	8-May	14-May	30-May
Gelderland	22,471.70		28,986.25		27,030.40
Holland	30,284.85		30,105.00		27,837.75
West-Friesland	23,091.80		29,123.60		
Utrecht		25,394.55		27,890.45	26,278.85
Friesland					27,419.17
Overijssel		23,877.80			
Deventer		26,306.85			
Kampen		24,396.55			
Zwolle City	24,116.85		27,586.30		27,804.95
Total	99,965.20	99,975.75	115,801.15	27,890.45	136,371.12
Grand Total	480,003.67				

Source: AMA 5077/1313

**Table A8. Monthly Flows: 1666 to 1703 in Bank Guilders**

	<u>Guilder Creation by Metal Inflows</u>		<u>Guilder Destruction by Metal Outflows</u>	
	“Coin Deposits” Receivers	“Bullion Purchases” Specie Camer	“Coin Withdrawals” Round Values	“Bullion Sales” Odd Values
Feb-66	42,281.95	0.00	12,060.00	17,726.88
Mar-66	17,631.75	0.00	421,942.00	15,030.28
Apr-66	55,413.20	346,000.00	227,226.00	105,405.70
May-66	92,164.03	127,501.60	49,448.00	125,898.75
Jun-66	66,628.95	30,000.00	833.00	7,413.03
Jul-66	134,581.98	100,000.00	199,040.00	66,083.47
Aug-66	269,442.73	1,223.75	45,690.00	19,349.83
Sep-66	181,391.53	0.00	85,368.00	15,278.05
Oct-66	6,063.40	0.00	93,501.00	13,460.00
Nov-66	11,344.80	0.00	19,497.00	12,904.00
Dec-66	1,723.10	0.00	97,174.00	105,545.35
Jan-67	0.00	0.00	84,506.00	209,289.35
Feb-67	5,666.95	12,000.00	2,516.00	31,667.90
Mar-67	3,911.75	19,223.10	21,928.00	119,202.98
Apr-67	43,451.53	9,863.75	108,923.00	156,628.80
May-67	20,656.10	17,898.10	146,668.00	57,984.18
Jun-67	9,303.00	13,238.55	22,705.00	44,185.53
Jul-67	9,870.30	30,300.38	32,217.00	72,909.75
Aug-67	1,000.00	12,000.00	79,980.00	27,386.80
Sep-67	12,679.50	42,073.90	189,302.00	107,987.45
Oct-67	2,060.50	0.00	275,652.00	74,613.98
Nov-67	14,537.35	12,000.00	183,364.00	340,681.90
Dec-67	1,074.50	12,000.00	366,740.00	13,159.95
Jan-68	5,775.70	0.00	47,486.00	36,121.00
Feb-68	35,867.35	0.00	188,989.00	76,232.75
Mar-68	8,260.00	6,000.00	303,322.00	77,171.25
Apr-68	10,744.00	330,701.80	299,259.00	139,993.30
May-68	7,128.40	1,437,506.25	300,638.00	147,324.68
Jun-68	5,548.90	82,176.18	68,993.00	90,181.73
Jul-68	19,091.50	61,236.20	93,215.00	99,446.75
Aug-68	23,396.00	34,166.17	22,006.00	30,366.63
Sep-68	12,941.50	5,810.63	13,241.00	38,153.17
Oct-68	7,259.80	44,632.75	56,306.00	45,533.77
Nov-68	13,627.60	44,419.25	183,430.00	31,601.70
Dec-68	14,407.15	0.00	52,315.00	12,496.25
Jan-69	11,376.50	2,391.80	42,000.00	18,943.45
Feb-69	39,286.20	0.00	2,030.00	14,882.90

Mar-69	28,162.10	6,000.00	3,772.00	19,579.40
Apr-69	5,600.00	6,000.00	17,290.00	76,818.15
May-69	14,670.00	18,000.00	8,829.00	23,639.25
Jun-69	305.50	20,610.70	14,123.00	8,238.33
Jul-69	39,348.20	15,564.70	27,376.00	21,568.05
Aug-69	67,135.30	18,000.00	5,887.00	9,013.05
Sep-69	53,504.00	73,726.60	5,889.00	7,547.40
Oct-69	36,889.35	0.00	65,291.00	15,060.60
Nov-69	100,741.45	2,387.50	27,079.00	137,058.65
Dec-69	294,380.30	3,888.15	50,335.00	23,614.15
Jan-70	17,923.85	76,000.00	24,009.00	1,659.00
Feb-70	108,314.75	25,748.05	840.00	5,013.75
Mar-70	79,802.30	45,520.48	5,179.00	12,531.00
Apr-70	279,390.38	101,164.38	40,689.00	17,844.63
May-70	200,993.00	483,741.45	125,735.00	10,910.50
Jun-70	125,639.55	148,622.20	11,004.00	16,772.88
Jul-70	121,593.10	0.00	4,432.00	7,919.05
Aug-70	139,628.25	815,231.20	8,283.00	3,355.50
Sep-70	137,260.03	1,415,986.48	257,001.00	573,082.22
Oct-70	91,050.75	229,519.45	75,786.00	26,545.10
Nov-70	74,448.15	131,008.00	91,176.00	21,786.48
Dec-70	121,171.35	139,721.88	148,987.00	30,581.00
Jan-71	243,924.75	128,101.30	52,038.00	7,705.35
Feb-71	277,492.55	59,626.55	2,505.00	7,560.00
Mar-71	293,073.40	2,981.40	18,665.00	844.50
Apr-71	114,742.98	0.00	129,335.00	62,673.20
May-71	274.00	842.70	90,409.00	70,272.75
Jun-71	28,717.65	5,000.00	428,959.00	183,927.55
Jul-71	0.00	0.00	644,761.00	54,174.80
Aug-71	6,006.30	751.25	301,470.00	9,447.50
Sep-71	32,144.80	1,194.25	436,628.00	211,452.98
Oct-71	0.00	0.00	521,353.00	8,430.00
Nov-71	2,100.00	11,378.60	165,363.00	52,643.20
Dec-71	3,005.00	31,694.72	22,267.00	10,776.00
Jan-72	6,608.35	94,975.90	7,526.00	3,357.75
Feb-72	28,985.90	0.00	31,200.00	7,587.00
Mar-72	8,840.00	362.40	2,752.00	43,275.45
Apr-72	17,807.80	1,977.42	4,243.00	7,554.00
May-72	61,561.40	492,991.48	840.00	16,087.50
Jun-72	88,319.22	2,205.00	2,478,372.00	291,351.73
Jul-72	184,624.65	124,543.08	497,630.00	28,198.90
Aug-72	36,767.85	900.00	44,475.00	1,160.65
Sep-72	60,398.10	32,908.30	68,234.00	20,114.50

Oct-72	15,109.70	141,521.70	3,807.00	10,978.90
Nov-72	33,357.90	0.00	17,870.00	6,684.00
Dec-72	19,019.50	2,422.05	3,844.00	5,995.50
Jan-73	931.40	81,112.15	13,683.00	11,762.25
Feb-73				
Mar-73				
Apr-73				
May-73				
Jun-73				
Jul-73				
Aug-73	19,496.50	46,196.25	0.00	7,985.15
Sep-73	161,096.95	222,601.32	1,695.00	0.00
Oct-73	198,788.75	272,967.28	0.00	0.00
Nov-73	95,726.95	129,162.38	0.00	0.00
Dec-73	17,608.30	132,844.53	2,460.00	6,897.50
Jan-74	3,007.00	148,456.25	6,771.00	16,868.25
Feb-74	37,689.65	6,380.60	2,231.00	5,937.00
Mar-74	825.30	33,477.60	3,432.00	5,955.00
Apr-74	3,468.70	10,773.95	29,706.00	7,582.38
May-74	1,747.30	31,773.50	175,013.00	31,501.25
Jun-74	1,887.90	84,048.65	138,407.00	25,434.00
Jul-74	0.00	207,612.90	172,931.00	41,257.75
Aug-74	317.30	129,572.48	145,276.00	16,933.65
Sep-74	771.00	31,718.85	15,516.00	34,929.90
Oct-74	10,405.40	18,945.45	61,159.00	42,939.90
Nov-74	1,679.10	69,453.35	76,100.00	9,014.25
Dec-74	6,074.00	17,025.95	110,571.00	10,293.02
Jan-75	0.00	362,830.25	1,698.00	25,602.00
Feb-75	4,338.97	118,484.35	33,487.00	1,707.00
Mar-75	3,019.90	0.00	31,296.00	5,150.68
Apr-75	6,141.00	0.00	75,102.00	170,103.80
May-75	2,495.80	0.00	113,865.00	50,837.07
Jun-75	6,560.60	2,562.50	138,637.00	15,207.50
Jul-75	11,515.90	0.00	161,774.00	0.00
Aug-75	21,882.47	843.75	105,108.00	17,551.13
Sep-75	916.65	0.00	9,366.00	40,367.90
Oct-75	1,250.65	0.00	13,450.00	12,515.82
Nov-75	0.00	0.00	177,964.00	308,633.05
Dec-75	0.00	0.00	15,948.00	132,890.10
Jan-76	8,709.50	24,333.00	25,803.00	39,794.70
Feb-76	13,307.90	0.00	8,319.00	13,891.25
Mar-76	8,828.30	0.00	22,619.00	54,737.50
Apr-76	500.00	0.00	0.00	241,665.50

May-76	8,822.15	0.00	9,200.00	20,477.50
Jun-76	5,700.00	41,425.00	0.00	0.00
Jul-76	16,915.55	273,883.57	0.00	27,346.90
Aug-76	1,581.80	346,481.10	3,090.00	1,694.00
Sep-76	400.00	25,493.60	0.00	0.00
Oct-76	3,604.20	0.00	0.00	0.00
Nov-76	346.30	4,214.75	50,650.00	878.75
Dec-76	363.60	2,831.80	1,745.00	6,455.95
Jan-77	370.30	25,687.50	10,616.00	9,439.45
Feb-77				
Mar-77				
Apr-77				
May-77				
Jun-77				
Jul-77				
Aug-77	7,111.65	15,978.30	85,820.00	98,266.40
Sep-77	450.60	0.00	130,784.00	69,522.85
Oct-77	307.90	0.00	27,103.00	132,552.20
Nov-77	58,044.50	0.00	436,334.00	409,548.10
Dec-77	14,375.70	0.00	78,314.00	1,747.20
Jan-78	16,434.10	0.00	73,820.00	66,953.15
Feb-78	23,952.00	0.00	7,500.00	5,240.15
Mar-78	800.00	4,460.00	9,000.00	4,280.70
Apr-78	600.00	10,022.60	0.00	4,267.90
May-78	2,283.30	18,674.65	6,000.00	2,556.85
Jun-78	1,211.00	177,557.65	0.00	3,352.85
Jul-78	6,140.25	189,009.85	854.00	1,725.40
Aug-78	9,015.25	30,399.75	0.00	0.00
Sep-78	0.00	18,022.60	27,224.00	5,701.10
Oct-78	0.00	44,495.95	0.00	2,400.20
Nov-78	844.70	10,475.00	189,570.00	123,344.75
Dec-78	0.00	0.00	0.00	8,653.05
Jan-79	644.40	35,159.45	10,800.00	5,119.20
Feb-79	6,569.05	3,086.00	0.00	9.23
Mar-79	2,417.00	0.00	2,606.00	4,324.20
Apr-79	477.33	71,640.10	19,078.00	12,148.80
May-79	1,248.40	11,683.20	0.00	0.00
Jun-79	0.00	5,950.10	22,263.00	857.50
Jul-79	812.00	0.00	0.00	5,171.10
Aug-79	34,193.30	22,672.60	0.00	0.00
Sep-79	410.00	8,893.22	0.00	0.00
Oct-79	12,791.68	0.00	0.00	2,937.27
Nov-79	19,560.25	170,200.80	0.00	206.25

Dec-79	3,718.40	994,726.08	22,200.00	0.00
Jan-80	3,774.95	398,093.43	850.00	0.00
Feb-80	9,068.75	807,539.45	0.00	2,602.95
Mar-80	1,614.90	351,608.68	0.00	1,749.20
Apr-80	523.00	91,019.88	0.00	1,890.05
May-80	0.00	23,384.40	16,098.00	0.00
Jun-80	450.00	36,513.50	881.00	884.80
Jul-80	879.15	11,485.30	847.00	850.75
Aug-80	1,000.00	1,105.00	0.00	2,603.00
Sep-80	410.00	9,012.50	869.00	1,716.70
Oct-80	310.50	6,065.60	847.00	0.00
Nov-80	0.00	5,295.60	24,612.00	153,029.20
Dec-80	0.00	0.00	100,000.00	64,326.35
Jan-81	0.00	0.00	600.00	0.00
Feb-81	800.00	0.00	0.00	2,634.10
Mar-81	606.80	0.00	0.00	5,215.10
Apr-81	600.00	9,977.87	631,315.00	128,315.70
May-81	2,200.00	22,518.85	24,000.00	29,296.75
Jun-81	636.50	0.00	0.00	89,417.30
Jul-81	3,897.50	0.00	0.00	30,613.40
Aug-81	624.00	0.00	97,125.00	60,810.30
Sep-81	0.00	0.00	109,590.00	59,799.40
Oct-81	1,200.00	11,834.90	0.00	6,712.85
Nov-81	16,786.40	0.00	2,500.00	501,789.50
Dec-81	8,865.20	0.00	4,075.00	55,193.45
Jan-82	18,000.00	173,820.97	1,845.00	2,649.20
Feb-82	7,482.95	85,315.42	878.00	4,470.15
Mar-82	5,160.90	0.00	4,700.00	56,944.05
Apr-82	500.00	0.00	209,253.00	26,773.07
May-82	460,656.23	0.00	95,763.00	78,272.02
Jun-82	659,556.27	42,480.80	0.00	6,225.40
Jul-82	212,945.23	0.00	3,428.00	2,660.45
Aug-82				
Sep-82				
Oct-82				
Nov-82				
Dec-82				
Jan-83				
Feb-83	184,182.38	0.00	1,670.00	6,924.25
Mar-83	357,589.70	1,847.40	36,605.00	4,954.35
Apr-83	154,233.10	0.00	317,860.00	12,986.15
May-83	74,066.40	0.00	69,052.00	11,704.85
Jun-83	91,458.70	0.00	34,333.00	5,618.40

Jul-83	92,490.00	1,704.45	79,414.00	11,119.73
Aug-83	188,894.50	0.00	64,566.00	10,050.55
Sep-83	167,101.78	0.00	123,477.00	9,767.60
Oct-83	4,530.00	1,963.03	345,429.00	101,454.70
Nov-83	122,451.93	0.00	214,866.00	81,728.70
Dec-83	37,709.50	5,993.95	161,552.00	55,987.65
Jan-84	10,485.00	0.00	275,112.00	32,708.85
Feb-84	13,683.00	0.00	73,097.00	7,153.65
Mar-84	17,589.00	22,115.40	161,097.00	23,129.30
Apr-84	9,784.93	361,688.92	114,982.00	204,887.35
May-84	132,032.70	243,664.63	92,181.00	143,689.98
Jun-84	188,574.00	20,656.35	87,063.00	61,044.70
Jul-84	302,832.00	61,072.75	83,044.00	68,196.88
Aug-84				
Sep-84				
Oct-84				
Nov-84				
Dec-84				
Jan-85				
Feb-85	59,613.20	0.00	177,525.00	23,789.30
Mar-85	90,448.13	0.00	335,682.00	98,249.03
Apr-85	194,290.50	461.30	235,364.00	131,520.00
May-85	135,725.00	868.65	305,484.00	44,659.85
Jun-85	177,386.00	0.00	171,196.00	40,915.00
Jul-85	87,948.00	3,322.80	107,650.00	30,471.15
Aug-85	71,098.20	198.10	50,425.00	26,277.05
Sep-85	685,587.40	0.00	6,705.00	15,981.60
Oct-85	173,985.00	1,909,653.70	348,795.00	159,926.65
Nov-85	255,815.05	121,388.35	253,706.00	74,069.80
Dec-85	405,705.50	1,667.00	176,448.00	99,035.90
Jan-86	433,556.65	615.35	67,996.00	20,322.80
Feb-86	197,181.55	736.55	238,669.00	29,934.45
Mar-86	46,080.00	0.00	331,510.00	36,147.43
Apr-86	146,397.00	0.00	77,953.00	34,860.15
May-86	49,549.60	485.50	381,787.00	42,081.25
Jun-86	217,282.80	0.00	55,361.00	31,877.95
Jul-86	274,323.80	164.85	31,433.00	60,160.60
Aug-86	149,666.60	254.10	64,948.00	28,885.25
Sep-86	253,821.90	1,355.95	41,825.00	30,535.50
Oct-86	678,557.90	5,005.50	195,766.00	35,305.20
Nov-86	393,131.00	959.70	224,175.00	84,708.95
Dec-86	119,610.45	18,799.40	362,834.00	612,842.00
Jan-87	590,355.55	167,380.98	28,721.00	29,758.35

Feb-87	342,139.00	3,699.00	33,650.00	33,103.50
Mar-87	421,221.85	5,469.10	1,750.00	38,143.80
Apr-87	464,544.20	21,793.10	3,627.00	42,363.20
May-87	326,724.00	3,694.90	26,803.00	34,675.40
Jun-87	375,232.50	45,386.58	11,283.00	32,011.98
Jul-87	248,930.35	871.20	7,872.00	30,469.48
Aug-87	315,502.50	104,129.25	9,762.00	32,765.25
Sep-87	513,033.00	196,871.55	17,805.00	27,504.10
Oct-87	888,687.70	51,826.15	247,620.00	75,146.45
Nov-87	194,124.60	2,338.00	556,685.00	36,169.25
Dec-87	15,783.00	114,714.03	959,013.00	57,639.93
Jan-88	1,125.00	23,868.02	345,366.00	58,116.10
Feb-88	4,950.00	84,316.90	58,608.00	39,685.00
Mar-88	51,508.50	54,698.22	34,030.00	59,278.55
Apr-88	214,215.10	164,898.08	3,614.00	47,514.00
May-88	251,861.50	41,396.27	125,116.00	51,934.75
Jun-88	444,427.85	109,463.20	3,630.00	42,275.55
Jul-88	478,896.20	100,710.63	30,030.00	37,151.75
Aug-88	285,388.65	3,419.95	48,291.00	51,037.20
Sep-88	289,154.50	114,435.07	78,015.00	32,292.85
Oct-88	846,116.55	35,591.55	36,362.00	38,199.15
Nov-88	487,246.80	143,593.58	539,663.00	38,718.90
Dec-88	133,548.00	264,442.55	740,048.00	33,777.02
Jan-89	13,173.00	42,915.50	485,865.00	29,264.40
Feb-89	122,770.50	49,079.23	39,593.00	36,919.00
Mar-89	169,889.40	49,327.67	143,946.00	56,456.40
Apr-89	16,086.00	24,812.35	598,185.00	135,268.12
May-89	75,954.00	119,297.22	14,085.00	34,649.35
Jun-89	147,739.20	108,929.80	81,399.00	61,867.97
Jul-89	190,473.50	22,660.05	4,486.00	64,139.25
Aug-89	297,603.60	63,848.57	10,608.00	47,095.10
Sep-89	221,104.50	81,086.97	1,206.00	34,513.60
Oct-89	180,741.30	105,669.60	2,650.00	39,152.00
Nov-89	187,760.60	166,762.30	371,373.00	207,432.35
Dec-89	20,400.00	95,522.40	398,868.00	39,476.30
Jan-90	0.00	19,615.45	160,795.00	50,338.92
Feb-90	0.00	78,751.20	66,809.00	54,667.95
Mar-90	0.00	25,945.40	1,650.00	72,894.15
Apr-90	4,740.00	97,700.15	8,495.00	64,903.55
May-90	43,716.00	247,207.68	3,563.00	77,838.10
Jun-90	261,723.00	3,311.60	9,319.00	76,428.95
Jul-90	116,354.30	637.88	890.00	44,439.20
Aug-90	267,780.00	25,868.25	6,299.00	89,145.30

Sep-90	138,244.70	189,287.20	1,812.00	65,507.00
Oct-90	332,921.10	160,733.87	18,208.00	78,588.60
Nov-90	559,305.15	236,744.33	41,058.00	61,481.35
Dec-90	93,817.50	349.40	927,224.00	65,420.55
Jan-91	5,616.00	52,688.00	88,902.00	49,506.38
Feb-91	7,494.00	1,585.85	273,832.00	109,971.53
Mar-91	47,700.00	2,397.95	96,739.00	135,059.03
Apr-91	13,270.50	1,614.45	255,776.00	164,138.85
May-91	95,480.00	2,517.80	128,288.00	450,312.75
Jun-91	453,760.00	348,902.88	2,747.00	55,687.50
Jul-91	94,815.00	98,993.85	63,330.00	55,924.47
Aug-91	634,382.20	306,059.88	38,982.00	71,940.85
Sep-91	204,453.00	1,636.45	9,211.00	61,379.47
Oct-91	177,498.60	2,091.30	6,893.00	60,090.80
Nov-91	190,813.80	2,077.75	489,169.00	185,428.65
Dec-91	133,944.50	617.35	384,140.00	44,415.00
Jan-92	120,310.40	827.70	93,425.00	69,134.80
Feb-92	128,121.00	489.05	73,169.00	46,457.10
Mar-92	128,306.50	750.05	271,149.00	89,860.68
Apr-92	273,315.00	240,584.25	139,418.00	164,992.70
May-92	313,365.00	238,189.73	131,074.00	178,449.40
Jun-92	161,854.00	844.82	438,318.00	97,404.35
Jul-92	148,197.70	0.00	234,942.00	166,335.60
Aug-92	143,322.00	145,356.60	145,979.00	67,395.80
Sep-92	191,897.00	900.05	90,915.00	71,355.15
Oct-92	278,040.90	232.20	19,674.00	68,656.35
Nov-92	680,177.63	11,863.05	48,455.00	71,187.90
Dec-92	270,530.15	380.40	168,328.00	230,200.75
Jan-93	273,875.30	1,618.40	204,517.00	71,746.92
Feb-93	189,815.65	1,645.60	274,921.00	115,916.35
Mar-93	71,071.50	1,036.00	300,014.00	92,286.90
Apr-93	73,757.85	848.50	377,685.00	72,471.75
May-93	285,020.40	374,528.10	858,679.00	173,674.33
Jun-93	188,712.77	3,447.85	422,798.00	100,566.10
Jul-93	84,470.60	1,806.65	224,124.00	62,751.00
Aug-93	220,997.20	10,110.15	129,343.00	53,373.00
Sep-93	40,623.00	1,331.00	86,628.00	54,585.65
Oct-93	96,540.00	1,752.25	133,843.00	61,629.75
Nov-93	289,878.00	2,885.75	76,779.00	47,728.85
Dec-93	257,745.00	66,204.13	497,125.00	73,100.85
Jan-94	63,888.00	57,727.27	37,878.00	47,411.30
Feb-94	106,005.00	1,945.85	224,802.00	64,672.95
Mar-94	83,284.00	1,942.05	216,590.00	59,290.95

Apr-94	15,747.00	125,121.53	292,345.00	49,925.35
May-94	55,410.00	1,022,275.45	228,580.00	56,609.60
Jun-94	207,507.00	298,151.93	98,022.00	65,563.80
Jul-94	43,857.00	182,252.77	50,948.00	58,163.90
Aug-94	62,349.00	576,368.20	101,476.00	57,266.95
Sep-94	10,125.00	2,813.90	226,467.00	47,678.05
Oct-94	26,592.00	64,115.20	112,239.00	44,143.40
Nov-94	25,737.00	20,463.10	309,909.00	300,312.27
Dec-94	40,506.00	128,805.57	365,157.00	85,704.35
Jan-95	35,118.00	179,740.70	6,621.00	31,202.80
Feb-95	46,684.30	2,856.00	15,919.00	44,765.20
Mar-95	27,636.00	2,108.25	123,943.00	65,230.60
Apr-95	4,986.00	22,366.80	281,830.00	43,157.00
May-95	22,184.30	24,468.50	204,971.00	49,828.00
Jun-95	49,196.50	137,404.30	79,836.00	253,656.63
Jul-95	0.00	2,749.98	84,212.00	291,572.30
Aug-95	3,600.00	3,921.00	53,507.00	44,850.70
Sep-95	59,589.00	11,351.55	61,854.00	36,098.30
Oct-95	205,669.50	5,652.00	13,261.00	244,618.50
Nov-95	130,863.80	28,858.40	224,037.00	46,820.13
Dec-95	55,140.00	85,730.80	58,571.00	42,127.75
Jan-96	88,128.20	32,675.23	19,889.00	58,477.55
Feb-96	179,979.10	6,673.15	115,244.00	76,721.75
Mar-96	149,403.00	8,008.20	17,372.00	57,250.90
Apr-96	137,732.30	36,303.23	70,171.00	56,238.75
May-96	138,771.00	304,043.18	123,066.00	66,894.90
Jun-96	133,998.00	96,978.43	181,541.00	62,116.70
Jul-96	34,402.00	72,280.38	22,573.00	56,540.10
Aug-96	100,982.00	101,314.52	15,132.00	57,564.85
Sep-96	25,954.50	34,728.65	248,374.00	38,865.85
Oct-96	80,223.60	38,853.70	47,562.00	235,678.85
Nov-96	97,574.70	10,353.35	99,833.00	86,673.35
Dec-96	155,232.55	45,018.80	290,850.00	30,647.15
Jan-97	123,383.20	161,004.30	7,788.00	69,762.35
Feb-97	199,219.70	90,696.00	7,148.00	41,515.45
Mar-97	216,923.00	46,972.95	63,253.00	49,048.90
Apr-97	251,432.00	44,003.20	697,509.00	47,140.00
May-97	502,977.85	30,159.32	155,454.00	93,267.90
Jun-97	547,987.40	30,686.30	13,417.00	57,735.30
Jul-97	452,420.00	21,096.45	3,751.00	38,411.25
Aug-97				
Sep-97				
Oct-97				

Nov-97				
Dec-97				
Jan-98				
Feb-98	51,042.00	1,835.25	12,892.00	23,016.12
Mar-98	216,798.00	15,189.48	142,377.00	29,509.90
Apr-98	6,888.00	33,180.12	233,110.00	237,245.33
May-98	402,185.30	42,003.20	207,678.00	37,903.92
Jun-98	179,351.90	8,420.30	13,471.00	57,640.02
Jul-98	154,964.40	3,751.15	22,442.00	67,041.35
Aug-98	255,661.00	78,688.35	373,486.00	47,891.60
Sep-98	329,362.90	528.45	365,242.00	49,625.30
Oct-98	409,924.90	706,765.30	3,220.00	40,335.27
Nov-98	300,261.20	899,359.70	780,586.00	25,894.67
Dec-98	199,486.90	71,153.55	426,599.00	34,842.73
Jan-99	239,540.70	5,278.60	4,849.00	34,341.58
Feb-99	202,214.50	0.00	226,775.00	50,755.60
Mar-99	244,456.00	300,000.00	516,603.00	162,951.07
Apr-99	135,708.00	1,049.40	38,544.00	126,532.97
May-99	116,241.00	836.65	143,258.00	85,931.45
Jun-99	305,985.40	0.00	258,471.00	114,059.22
Jul-99	193,570.50	541.75	131,634.00	209,086.80
Aug-99	281,760.00	0.00	12,393.00	95,752.83
Sep-99	230,132.50	15,454.98	20,595.00	57,793.25
Oct-99	202,075.00	669.20	87,109.00	117,560.53
Nov-99	343,926.55	0.00	250,785.00	49,087.97
Dec-99	338,751.00	0.00	473,692.00	38,129.68
Jan-00	295,651.00	887.00	162,391.00	49,528.42
Feb-00	414,494.00	0.00	92,656.00	49,365.63
Mar-00	294,717.00	0.00	287,522.00	101,260.07
Apr-00	202,891.60	1,418.90	888,665.00	46,190.45
May-00	113,160.00	35,782.25	1,904.00	57,833.35
Jun-00	158,005.00	78,574.32	13,019.00	51,952.15
Jul-00	217,719.70	42,656.53	14,613.00	75,711.50
Aug-00				
Sep-00				
Oct-00				
Nov-00				
Dec-00				
Jan-01				
Feb-01	1,000,918.00	76,062.00	10,842.00	15,740.85
Mar-01	295,339.00	15,252.60	78,514.00	101,112.77
Apr-01	438,613.65	33,020.80	898,806.00	79,438.60
May-01	476,311.20	12,616.00	31,606.00	55,779.05

Jun-01	240,974.00	439.00	23,500.00	59,903.60
Jul-01	297,155.00	585.70	50,850.00	181,757.35
Aug-01	674,192.50	0.00	546,573.00	215,119.93
Sep-01	151,970.00	511.50	315,060.00	74,588.87
Oct-01	107,983.50	0.00	485,866.00	146,374.82
Nov-01	127,254.00	572.40	553,705.00	99,400.80
Dec-01	172,701.00	0.00	457,281.00	134,440.05
Jan-02	97,540.00	1,856.88	75,246.00	55,962.98
Feb-02	186,039.50	12,400.00	146,978.00	73,961.33
Mar-02	273,878.95	2,669.50	48,937.00	54,078.15
Apr-02	153,588.45	3,594.70	80,264.00	184,334.42
May-02	141,577.20	0.00	92,276.00	86,812.15
Jun-02	101,424.00	0.00	100,298.00	61,564.60
Jul-02	77,450.15	0.00	6,828.00	38,648.30
Aug-02	95,793.00	0.00	192,896.00	42,243.35
Sep-02	26,519.00	0.00	43,261.00	84,601.35
Oct-02	153,122.00	18,441.85	204,600.00	39,448.90
Nov-02	64,903.75	13,446.30	666,366.00	36,393.90
Dec-02	52,639.00	11,822.32	461,310.00	134,852.70
Jan-03	16,509.00	45,754.70	87,529.00	53,628.35

**Table A9. Calculation of Withdrawal Revenue**

Fiscal Year	Revenue	Change in VOC Interest Due	VOC Interest	Holland Interest	"Withdrawal" Revenue	Metal Outflow through Specie Kamer	Ratio
1666	39,934	-4,025	-11,750	-8673	15,487	2,049,670	0.76%
1667	57,861	-2,361	-26,667	-8673	20,141	2,560,011	0.79%
1668	74,949	-10,022	-35,933	-8673	20,340	2,431,159	0.84%
1669	42,313	18,333	-46,283	-8673	5,690	610,589	0.93%
1670	20,861	0	0	-8673	12,189	1,555,197	0.78%
1671	56,491	0	-6,362	-8673	41,633	3,344,676	1.24%
1672	88,594	0	-800	-8673	79,119	3,617,700	2.19%
1673							
1674	28,794	0	-942	-8673	19,177	1,189,420	1.61%
1675	49,354	0	-8,489	-8673	32,193	1,696,559	1.90%
1676	57,506	-15,507	-32,678	-8673	647	482,826	0.13%
1677	74,023	-35,506	-5,509	-8673	24,336		
1678	74,636	37,680	-99,455	-8673	4,186	417,590	1.00%
1679	78,004	0	-64,000	-8673	5,332	92,651	5.75%
1680	63,534	5,000	-56,111	-8673	3,750	374,407	1.00%
1681	79,889	3,333	-41,789	-8673	32,760	1,842,897	1.78%
1682	56,497	1,667	-31,745	-8260	18,159		
1683	42,598	-1,866	-18,689	-8260	13,782	2,068,942	0.67%
1684	64,987	5,199	0	-8260	61,926		

Source: van Dillen 1925: 701-807, and authors' calculation.

**Table A10. The VOC-AWB Credit Relationship**

	1	2	3	4	5	6
FY Ending	AWB Loans in bank guilders	VOC External Debt in current guilders	AWB's Share	AWB Lending	VOC Expenditures	AWB's Share
4/30/1667	300,000	12,068,477	3%	300,000	7,767,160	4%
4/30/1668	600,000	14,776,188	4%	800,000	10,358,418	8%
4/30/1669	1,100,000	15,584,693	7%	1,600,000	9,962,440	17%
4/30/1670	100,000	14,205,462	1%	500,000	7,408,009	7%
4/15/1671	0	12,254,925	0%	0	8,042,724	0%
4/15/1672	0	11,779,872	0%	1,300,000	8,440,686	16%
4/15/1673	0	14,456,424	0%	0	5,970,759	0%
4/15/1674	0	13,392,636	0%	0	4,863,855	0%
4/15/1675	0	12,558,813	0%	700,000	8,688,494	8%
4/15/1676	0	13,099,801	0%	1,850,000	8,960,247	22%
4/15/1677	1,200,000	11,513,962	11%	700,000	9,553,385	8%
4/15/1678	800,000	12,289,233	7%	1,600,000	8,277,794	20%
4/15/1679	1,500,000	12,205,185	13%	100,000	5,953,366	2%
5/31/1680	1,600,000	11,175,629	15%	0	8,238,865	0%
5/31/1681	1,300,000	11,050,717	12%	0	8,030,878	0%
5/31/1682	1,000,000	10,397,454	10%	500,000	8,738,099	6%
5/31/1683	600,000	8,254,522	8%	1,500,000	7,711,769	20%
5/31/1684	0	8,509,926	0%	1,200,000	7,902,883	16%
5/31/1685	400,000	9,320,289	4%	1,200,000	9,342,818	13%
5/31/1686	1,200,000	9,379,135	13%	2,600,000	9,213,639	29%
5/31/1687	1,800,000	8,526,588	22%	2,100,000	9,101,201	24%
5/31/1688	2,000,000	7,618,671	27%	1,000,000	9,762,741	11%
5/31/1689	600,000	7,168,758	9%	1,200,000	9,084,777	14%
5/31/1690	700,000	7,502,565	10%	1,000,000	8,679,884	12%
5/31/1691	600,000	6,540,960	10%	200,000	8,737,656	2%
5/31/1692	0	6,930,417	0%	1,400,000	8,056,246	18%
5/31/1693	0	6,566,856	0%	400,000	11,020,009	4%
5/31/1694	0	7,172,006	0%	1,800,000	10,718,641	18%
5/31/1695	200,000	7,134,778	3%	1,950,000	10,275,190	20%
5/31/1696	250,000	6,578,286	4%	1,150,000	11,217,275	11%
5/31/1697	0	7,441,164	0%	1,900,000	11,153,469	18%
5/31/1698	0	8,790,546	0%	3,000,000	8,863,991	35%
5/31/1699	0	7,637,538	0%	1,200,000	15,054,157	8%
5/31/1700	0	7,565,911	0%	1,300,000	11,332,523	12%
5/31/1701	0	8,723,226	0%	3,600,000	13,783,169	27%
5/31/1702	1,000,000	8,730,226	12%	3,300,000	12,399,812	28%

Source: VOC data from de Korte (1984: 1A-1C).

## Appendix B. Theoretical illustrations

This appendix offers a formal examination of the efficiency gains stemming from changes in the AWB's credit policies following the 1683 reform. The model environment considered builds in a natural financial intermediary and payments provider role for the Bank of Amsterdam, i.e., the bank is endowed with advantages in these capacities. The model then traces through the consequences of the bank's transition to a fiat standard.

Time is discrete and infinite in the model environment. Time is indexed by  $t$ , and each period (which can be thought of as a "year" for convenience) is subdivided into 3 stages  $\{0,1,2\}$ , referred to as winter, spring/summer, and autumn. There are 2 classes of agents, *domestic* and *foreign*. Foreign agents have measure 1 and domestic agents have measure  $\frac{1}{2}$ .<sup>49</sup> Agents are ex ante identical within a class. Domestic agents coordinate their production and consumption decisions and function as a single agent. In addition to private agents, there is an exchange bank whose activities are described below. Economic activity takes place in 2 locations, the domestic economy ("Amsterdam") and elsewhere ("abroad").

### *Synopsis of the model*

The model incorporates a stylized cycle of trade. Foreign agents (natural lenders) earn silver abroad in the winter and bring it to Amsterdam in spring, in search of trading opportunities. Silver is exchanged with the coalition of domestic agents (a natural borrower) in return for bank money that can be used to purchase goods in Amsterdam. Domestic agents use the silver they obtain for consumption abroad, while engaged in productive activities (overseas expeditions) that do not return goods until the autumn of the same year.

At the beginning of autumn, some foreign agents experience a liquidity (i.e., preference) shock, meaning they must depart Amsterdam in order to consume. Also in autumn, goods arrive in Amsterdam from summer productive activities undertaken by domestic agents. Foreign agents not experiencing a liquidity shock may either purchase these goods with bank money, or may choose to liquidate their bank balances for silver, which can then be used to purchase consumption goods abroad. Table 1 summarizes the timing of actions in the model.

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<sup>49</sup> The labels "domestic" and "foreign" are more handy than accurate. "Long-term participants in the Amsterdam markets" and "opportunistic participants" might be more exact.

<b>Table 1: Timing of actions in the model</b>			
<i>Time of year</i>	<i>Foreign agents</i> (overlapping generations)		<i>Domestic agents</i> (infinitely lived)
Winter (stage 0)	Young foreign agents trade production goods abroad for silver		
Spring (stage 1a)	Young arrive in Amsterdam; trade silver for bank money; old (liquidity constrained) trade money for silver and depart Amsterdam		Trade money for silver in Amsterdam
Summer (stage 1b)	Old, liquidity-constrained agents purchase consumption goods abroad		Use silver to purchase consumption abroad; Begin production
Early autumn (stage 2a)	Liquidity shock revealed for young agents		Goods arrive in Amsterdam from summer production
	<i>If liquidity shock</i>	<i>If no shock</i>	
Autumn (stage 2b)	No action; wait to trade money for silver next period	Use money to purchase goods from domestic agents & consume	Sell goods to domestic agents for money

### *Commodities and feasible trades*

There are 3 commodities: a nondurable general consumption good, a nondurable special consumption good, and a durable good, silver, which is used for only for trade. Silver can be stored at negligible cost.

All trading outside Amsterdam is of silver for the other goods, and always at the world price of  $\phi$  units of silver per good, normalized to  $\phi = 1$  for both goods. All trading within Amsterdam is of goods for money (bank balances, described below). For expositional clarity, domestic agents may not purchase silver by issuing IOUs to foreign agents.<sup>50</sup> Likewise, foreign agents may not directly purchase special goods from domestic agents with silver, but must use money to make their purchases. Finally, domestic agents must sell their special good production in their “home market,” Amsterdam.

<sup>50</sup> This constraint could be partially relaxed without qualitatively changing the model results. What matters is that foreign agents are less willing to accept domestic agents’ debt than is the bank.

*Preferences, endowments, and technologies*

Each generation of foreign agents lives for 2 years. A generation- $t$  foreign agent is born abroad in stage 0 of the year  $t$  and can produce  $x_{0t}$  units of the general good for sale on the world market. He (typically) journeys to Amsterdam in stage 1, although the agent always has the option of remaining abroad and trading exclusively in the world market. At the beginning of stage 2, a foreign agent experiences a shock that determines his preferences for general good versus special good consumption. The utility of a generation- $t$  foreign agent  $i$  is

$$U_i = -x_{0t}^i + \lambda_{2t}^i \beta u(c_{1,t+1}^i) + (1 - \lambda_{2t}^i) u(f_{2t}^i) \quad (4)$$

where  $\beta$  is an annual discount factor,  $c_{1,t+1}^i$  represents  $i$ 's consumption of the general good (which takes place in the summer of year  $t + 1$ ),  $f_{2t}^i$  represents his consumption of the special good (which typically takes place in the autumn of year  $t$ ),<sup>51</sup>  $\lambda_{2t}^i$  is a preference shock, and  $u$  is a concave utility function. To allow for analytic results, we take  $u(c) = c^{(1-\rho)} / (1-\rho)$  where  $\rho \in (0,1)$ . The probability distribution for  $\lambda_{2t}$  is

$$\lambda_{2t} = \begin{cases} 1 & \text{with probability } 1/2, \\ 0 & \text{with probability } 1/2. \end{cases} \quad (5)$$

An agent who receives a preference shock  $\lambda_{2t} = 1$  is said to be “liquidity constrained,” in the sense that the agent *only* wants to consume the general good, which is *only* available abroad for silver. The remaining (called “unconstrained”) foreign agents want to consume the special good, either abroad or in Amsterdam, depending on market conditions. An agent’s type (constrained or not) is private information.

Domestic agents are infinitely lived and have objective

$$V = \sum_{t=0}^{\infty} \beta^t (d_{1t} - ax_{1t}) \quad (6)$$

where  $d_{1t}$  is the agent’s summer (stage 1) consumption of the general good abroad,  $x_{1t}$  is the summer production of the special good undertaken by the agent, and  $a \in (0, \beta)$ . There is no discounting from spring to autumn. Productive effort  $x_{1t}$  yields  $y_{2t} = x_{1t}$  special goods which are brought to Amsterdam. Domestic agents cannot earn silver abroad, so silver for their general

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<sup>51</sup> This is a slight abuse of notation: the special good may also be purchased on the world market and consumed in the spring of the next year, although this does not occur in the equilibria we consider.

good consumption must be obtained through trade in Amsterdam with foreign agents. Foreign agents have an incentive to trade with domestic agents in the Amsterdam market, since domestic agents can produce the special good at a cost below the world price of one.<sup>52</sup>

Silver can be held by domestic agents, foreign agents young or old, or the exchange bank (described below). Let  $S_{1t}^y(S_{1t}^o)$  be the per-capita, non-negative amount of silver held by old foreign agents at the end of stage 1a money market trading, and let  $S_{1t}^d(S_{2t}^d)$  be domestic agents' stage 1a (stage 2) per-capita silver holdings (again nonnegative). The amount of silver (per domestic resident) held at the exchange bank after stage 1(2) trading is  $S_{1t}^b(S_{2t}^b)$ .

### *Efficient steady-state allocations*

As a benchmark, we first consider efficient steady-state allocations. The planner maximizes the population-weighted discounted utility of all agents, i.e.,

$$W = V/2 + \sum_{t=0}^{\infty} \beta^t E(U_t) \quad (7)$$

over allocations  $(x_{0t}, x_{1t}, d_{1t}, c_{1t}, f_{2t}, S_{1t}^y, S_{1t}^o, S_{1t}^d, S_{2t}^d, S_{1t}^b)$ . Feasibility constraints are

$$2x_{0t} + S_{2,t-1}^d + S_{1,t-1}^b + 2S_{1,t-1}^y \geq 2S_{1,t}^y + S_{1,t}^o + S_{1,t}^d + S_{1,t}^b, \quad (8)$$

$$S_{1,t}^o \geq c_{1t}, \quad (9)$$

$$S_{1,t}^d \geq d_{1t} \quad (10)$$

$$x_{1t} \geq f_{2t}. \quad (11)$$

Constraint (8) says that the total silver available to the Amsterdam economy in stage 1a consists of silver imported by young foreigners plus any silver stored by domestic agents, the bank, and old foreigners. Constraint (9) says that the general good consumption of foreigners is limited by the amount of silver they have available. A similar constraint (10) applies to consumption by domestic agents. Constraint (11) is the resource constraint on special good consumption by foreigners. The truth-telling condition for the planner's problem is

$$u(f_{2t}) \geq \beta u(c_{1,t+1}), \quad (12)$$

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<sup>52</sup> I.e., the law of one price does not hold for special goods. Sufficient frictions operate in the background to allow this situation to persist.

i.e., an unconstrained foreign agent must do at least as well by consuming domestically as he could by reporting himself as a constrained agent, accepting a silver payment, and then using the silver to purchase the special good abroad the following year. Participation constraints for foreign and domestic agents are

$$EU, V \geq 0. \quad (13)$$

The set of planner's allocations (superscript  $p$ ) is described as

$$u'(c_1^p) = 1, \text{ i.e., } c_1^p = S_1^{o,p} = 1 \quad (14)$$

$$u'(f_2^p) = a, \text{ i.e., } f_2^p = x_1 = a^{-(1/\rho)} \quad (15)$$

$$d_1^p = S_1^{d,p} \in [af_2^p, \bar{d}], \text{ where } \bar{d} = u(c_1^p) + u(f_2^p) - c_1^p \quad (16)$$

$$2x_0 = c_1^p + d_1^p \quad (17)$$

$$S_2^{d,p} = S_1^{b,p} = S_1^{y,p} = 0 \quad (18)$$

Conditions (14) and (15) are standard optimality conditions. Note that truth-telling condition (12) does not bind in the planner's allocation. Condition (16) says that domestic agents' consumption is indeterminate between the bounds imposed by individual rationality for both classes of agents. Condition (17) says that silver imports by young foreigners must be sufficient to cover general good consumption by domestic agents and old foreigners. Silver carries an opportunity cost and has no liquidity value over the winter, so the planner sets inter-period holdings of silver by domestic agents, the bank, and foreigners equal to zero (condition (18)).

### *The exchange bank*

Money takes the form of balances at an exchange bank. Initially we assume the bank does not engage in lending. More specifically, the exchange bank credits any deposits of silver into the exchange bank at a fixed number of units of silver  $\bar{\theta}$  per florin of bank money, normalized to  $\bar{\theta} = 1$ . Withdrawals from the bank occur at a mandated price  $\underline{\theta} < 1$ .

In the decentralized economy, money can be traded for silver in stage 1a. The market value of money in terms of silver is  $\theta$  units of silver per unit money ("florin").<sup>53</sup> Absence of arbitrage

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<sup>53</sup> I.e., the price of bank money is proportional to one plus the agio. As explained above, the actual agio expressed the price of bank money relative to current money, whose metallic value could vary over time. While a model of current money valuation could be incorporated in to the model, we abstract from this complication to keep notation manageable.

requires that the market price of bank money be in the interval  $[\underline{\theta}, 1]$ . As long as the market price of money is in this interval, there is (weakly) no incentive for agents to deposit or withdraw silver from the bank: hence, for steady states (i.e., for constant  $\theta$ ) we exclude the possibility of deposits or withdrawals.

However, anyone with funds at the exchange bank has the *option* of withdrawing funds from the bank at any time. Suppose that at a given moment the bank has liabilities (accounts) of  $M$  florins per domestic resident and holds  $S^b$  units of silver (“coins”) in its vault. Strictly speaking, the depositors’ right of withdrawal means that the exchange bank faces a liquidity constraint on its metal-to-deposit ratio  $S^b / M$  <sup>54</sup>

$$S^b / M \geq \underline{\theta} . \quad (19)$$

Taken at face value, this would require that the bank maintain a metal-to-deposit ratio of around 98 percent. As we have seen above, in practice the AWB was generally able to operate with a smaller ratio. Hence (19) is modified to

$$S^b / M \geq \delta \underline{\theta} , \quad (20)$$

for some “comfort factor”  $\delta < 1$ .

The special consumption good is traded in Amsterdam in stage 2 at money price  $p_t$ . Since unconstrained foreigners can choose where to consume the special good in stage 2, the silver-equivalent price of special goods in Amsterdam  $\sigma_t \equiv (\theta_t p_t)$  (i.e., the terms of trade for domestic agents) can be no greater than the silver price of goods abroad (one).

### *Steady-state monetary equilibria*

In the decentralized economy, young foreign agents wishing to purchase goods in Amsterdam must first use their silver earnings to purchase money holdings  $M_t^y$ . Foreign agents maximize the expectation of utility (4) over  $x_0$ ,  $c_1$ ,  $f_2$ ,  $M_1^y$ , and  $S_1^y$ , taking prices as given, subject to budget constraints

$$x_{0t} = \theta_t M_{1t}^y + S_{1t}^y \quad (21)$$

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<sup>54</sup> Following the Diamond-Dybvig tradition, constraint (19) could be motivated as necessary to prevent sunspot-based runs on the exchange bank. Runs can occur since types are unobservable and unconstrained agents can always obtain the special good abroad.

$$\theta_{t+1}M_{1t}^y + S_{1t}^y \geq c_{1,t+1} \quad (22)$$

$$M_t^y \geq p_t f_{2t} \quad (23)$$

Steady-state optimality conditions for foreign agents reduce to

$$(\frac{1}{2})(\beta\sigma u'(\sigma f_2) + u'(f_2)) = \sigma \quad (24)$$

In addition, it can be shown that a young foreign agent will always liquidate his silver earnings for money. If he is unconstrained, he will spend this money to purchase the special good; if he is constrained, he will trade it the following year to obtain silver to purchase the general good.

Condition (24) implicitly defines a function  $\sigma = g(f_2)$  where  $g$  can be shown to be strictly decreasing and strictly convex for coefficient of relative risk aversion  $\rho \in (0,1)$ . The inverse demand curve for special goods  $\sigma(f_2)$  is then given by

$$\sigma(f_2) = \begin{cases} 1, & \text{for } f_2 < 1, \\ g(f_2), & \text{for } f_2 \geq 1. \end{cases} \quad (25)$$

The kink in the inverse demand curve occurs because the domestic silver-equivalent price for the special good cannot exceed the world price of unity. Domestic agents' total revenue from special good sales can then be expressed as

$$TR(f_2) = f_2\sigma(f_2) \quad (26)$$

which can be shown to be strictly increasing and concave (strictly for  $f_2 > 1$ ).

A domestic agent in the decentralized economy maximizes his objective (6) subject to stage 1a, stage 1b, and stage 2 budget constraints

$$S_{2,t-1}^d + \theta_t M_{2,t-1}^d \geq S_{1t}^d + \theta_t M_{1t}^d \quad (27)$$

$$S_{1t}^d \geq d_{1t} + S_{2t}^d \quad (28)$$

$$M_{1t}^d + p_t x_{1t} \geq M_{2t}^d \quad (29)$$

over  $d_{1t}, x_{1t}, S_{1t}^d, S_{2t}^d, M_{1t}^d, M_{2t}^d$  where  $M_{it}^d$  denotes the agent's money holdings at the end of stage  $i$  of period  $t$ . Production decisions  $x_{1t}$  are made cooperatively, i.e., production is set so as to maximize monopoly profits. Steady-state first-order conditions for domestic agents reduce to

$$x_1 = \begin{cases} 1, & \text{if } TR'(1) < a/\beta \\ [TR']^{-1}(a/\beta), & \text{if } TR'(1) \geq a/\beta \end{cases} \quad (30)$$

where  $TR'$  is the right derivative of  $TR$ . That is, the coalition of domestic agents sets marginal revenue  $TR'$  from its sales of the special good equal to marginal cost (where the latter is adjusted for the time cost of money), if this cost is sufficiently low. Otherwise, domestic agents produce just enough of the special good to equate its silver-equivalent price in Amsterdam to the world price.

A *steady-state monetary equilibrium* is an allocation, combined with a set of per-capita money holdings  $M_1^y$ ,  $M_1^d$ ,  $M_2^d$ , and prices  $p$  and  $\theta$  ( $= \theta_1 = \theta_2$ ), for which (a) first-order conditions (24) and (30) hold, and (b) markets clear. Money market clearing in particular requires

$$M_2^d = M_1^y + M_1^d, \quad (31)$$

i.e., that sales of money by domestic agents  $M_2^d - M_1^d$  plus sales by old foreigners  $M_1^y$  equal purchases by young foreigners  $2M_1^y$ . Equilibria are described as

*Proposition 1.* There is a continuum of steady-state monetary equilibria where

- (1) Allocations, the silver-equivalent price of special goods  $\sigma = \theta p$ , and the real stock of bank money are the same in every equilibrium;
- (2) The price of money and the money price of special goods are indeterminate in the intervals  $\theta \in [\underline{\theta}, 1]$ ,  $p \in \left[ \sigma, \frac{\sigma}{\underline{\theta}} \right]$ ;

- (3) The nominal money stock varies with  $\theta$  the according to

$$M = d_1 / \theta \quad (32)$$

where  $d_1$  is the equilibrium consumption of the general good by domestic agents;

- (4) Money is held exclusively by foreigners over the summer, and by domestic agents and old foreigners over the winter

$$M_2^d = M_1^y = M; \quad M_1^d = 0; \quad (33)$$

- (5) Neither domestic nor foreign agents store silver over the winter

$$S_2^d = S_1^y = S_1^o = 0; \quad (34)$$

- (6) The exchange bank stores sufficient silver to satisfy its liquidity constraint (20)

$$S_1^b = S_2^b = \delta \underline{\theta} M = \delta (\underline{\theta} / \theta) d_1. \quad (35)$$

*Proof* (Sketch). There are two cases to consider.

Case 1:  $TR'(1) < a/\beta$ . In this case the equilibrium allocation can be derived as follows: from (30), domestic agents produce just enough special goods to satisfy demand at the world silver-equivalent price of one, so  $\sigma = 1$ . From inverse demand (25) and market clearing, it follows that  $d_1 = f_2 = 1$ . Using budget constraints (21) and (23), it follows that  $c_1 = 1$ .

The rest of the equilibrium is then constructed as follows. Absence of arbitrage in the money market requires  $\theta \in [\underline{\theta}, 1]$ ; hence if  $\sigma$  is determined it must be the case that  $p \in \left[ \sigma, \frac{\sigma}{\underline{\theta}} \right]$ . For domestic agents, holding silver over the summer is clearly dominated by consumption, hence their summer money holdings are zero. All winter asset holdings by domestic agents then take the form of money as in (32), and in equilibrium this must equal money expenditure by the unconstrained foreign agents as in (33).

Case 2:  $TR'(1) \geq a/\beta$ . In this case, from (30), domestic agents optimally produce  $x_2^* = [TR']^{-1}(a/\beta)$ , hence  $f_2 = f_2^* = x_2^*$  from market clearing. Then from inverse demand (25),  $\sigma = \sigma^* = \sigma(f_2^*) < 1$ ; using budget constraints (21)-(23) and (27)-(29), and market clearing, it follows that  $c_1 = d_1 = d_1^* = f_2^* \sigma(f_2^*) = TR(f_2^*)$ . The rest of the equilibrium is constructed as in the previous case.

*Corollary.* Any steady-state monetary equilibrium in the decentralized economy is inefficient.

*Proof.* In case 1, the equilibrium domestic agents' general good consumption  $d_1$  and foreign agents' general good consumption  $c_1$  is in the set of planner's allocations described by (14)-(18). However, monopoly pricing by domestic agents causes the foreign agents' consumption of the special good  $f_2$  to fall below its efficient value.

In case 2, foreign agents again underconsume the special good relative to the planner's allocation due to monopoly pricing. Since foreign agents' general good consumption (=domestic agents' consumption =  $TR$ ) is greater than one in this case, it follows that foreign agents also overconsume the general good.

In both cases, the relative price of the special good is higher than the corresponding shadow price  $a$  in the planner's allocation. Also, in both cases the bank inefficiently stores silver over the winter as backing for agents' money holdings, needed to fund next summer's purchases of general goods.

### *Discussion*

The steady-state monetary equilibrium mimics some features of the pre-1683 situation in Amsterdam. Coin (silver) is traded for money and money for goods. The equilibrium stock of bank money is constant over the trading "year" and its value lies anywhere between the bank's purchase price and sale price. The nominal stock of money can vary somewhat across steady states. Essentially the economy functions on a "silver in advance" basis, i.e., trading in the domestic market proceeds as if domestic goods were traded for silver at price  $\sigma = p\theta$ .

The inefficiency of the monetary equilibrium stems from three sources. The first source of inefficiency is simply the deadweight cost of the silver  $S_1^b$  necessary to support the exchange bank arrangement which, from (35), is decreasing in the market value of money  $\theta$ . The second source is the credit constraint on domestic agents, who must finance their stage 1 consumption from their previous year's earnings. The final source of inefficiency is the monopoly pricing undertaken by the domestic agents. The Corollary states that in equilibrium, these latter two factors in combination lead to an inefficiently high relative price and diminished consumption of the special good. Consumption of the general good may also be inefficiently subsidized.

### *Monetary steady states with receipts*

A receipt system is now introduced into the model. Specifically, suppose that in addition to its previous activities, the exchange bank is willing to issue receipts against deposited silver. The receipt allows its holder to purchase the deposited amount of silver, at the price of  $\bar{\theta} = 1$ .<sup>55</sup>

Under the receipt system, a foreign agent arriving in Amsterdam in stage 1 may sell silver in two ways: (1) directly trade silver for bank funds, or (2) deposit the silver into the exchange bank, thereby obtaining access to bank funds (at the bank's purchase price  $\bar{\theta} = 1$  units of silver per florin) and a receipt, which can be sold for additional bank funds. The market value of the receipt in stage 1a of period  $t$  is  $\lambda_t$  florins. Absence of arbitrage requires

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<sup>55</sup> For algebraic transparency, we ignore the small fees that were charged to redeem a receipt.

$$\theta_t = \frac{1}{1 + \lambda_t}, \quad (36)$$

Under (36), a foreign agent is indifferent between trading silver on the open market and trading receipts on deposited silver. Below we consider equilibria where an indifferent agent always chooses to deposit his silver and sell receipts against some portion of it. Let  $D_1$  denote the amount of silver deposited by a foreign agent in stage 1, and let  $L_1$  denote the quantity of receipts sold by the agent in stage 1 trading. When silver is traded exclusively as receipts, clearing in the stage 1a silver market requires that

$$M_2^d = (1 + \lambda)L_1 \quad (37)$$

i.e., money held by domestic agents must cover the cost of redeeming deposited coin at full value ( $\bar{\theta} = 1$ ) plus the cost of the receipts necessary for redemption.

Using (36), it is then straightforward to show that foreign agents' first-order condition (24) is exactly as in the previous model. The domestic agents' optimization problem is also unchanged from the earlier analysis; in particular, condition (30) is identical with the no-receipt case.

A *steady-state monetary equilibrium with receipts* consists of, in addition to the list of quantities for a monetary equilibrium without receipts, a quantity of stage 1 deposits  $D_1$  and of receipts  $L_1$ , and a money price of receipts  $\lambda$  such that conditions (24) and (30) hold and markets clear. From the foregoing discussion we have

*Proposition 2.* With receipts, there is a continuum of steady-state equilibria; each equilibrium is identical to an equilibrium with receipts, except in the following details:

- (1) The money price of receipts  $\lambda$  is indeterminate in the interval  $(0, \underline{\theta}^{-1} - 1)$ , where the implied silver value of money  $\theta = 1/(1 + \lambda)$  and the money price of domestic goods  $p$  fall in the same ranges as in Proposition 1;
- (2) Period 1 deposits of foreign agents are  $D_1 = c_1$ ;
- (3) Period 1 receipt sales of foreign agents are

$$L_1 = \theta M_2^d = d_1; \quad (38)$$

*Discussion*

Proposition 2 indicates that (absent aggregate liquidity shocks) the introduction of the receipt system would not in of itself have changed real allocations in the Amsterdam money markets. The value of bank money remains indeterminate and the inefficiency of the monetary equilibrium persists.

There is however a substantive difference between the equilibria described in Propositions 1 and 2. If bank money cannot be redeemed without a receipt, then following the money market trades in stage 1a, the value of claims on the banks' stock of silver would have also been reduced relative to the no-receipt case. This would have expanded the scope for the bank's credit activities.

### *Lending operations before receipts*

In practice the operation of the AWB incurred costs, which were offset through earnings on its loans. These elements are now introduced into the model.

Momentarily assume that the bank has access to sufficient capital so that its liquidity constraints are not binding. The annual operating cost of the exchange bank is  $\gamma > 0$ , which is expressed in silver terms. The bank obtains silver by trading money for silver in the stage 1 markets at price  $\theta$ . This money is earned through loans to domestic agents in stage 1, which are repaid at stage 2. Domestic agents may borrow up to  $q_t B_t$  florins, where  $q$  is the bank's discount and

$$B_t \leq \ell p_t x_{1t} \quad (39)$$

for  $\ell \in (0,1)$ , i.e., a domestic agent can borrow at most a fraction  $\ell$  of his anticipated autumn special goods sales. The bank's breakeven constraint is

$$\theta_t(1 - q_t)B_{t-1} \geq \gamma . \quad (40)$$

The bank does not seek to maximize profits from lending, but simply sets  $q$  to recover costs.

Domestic agents' budget constraints (27) and (29) are replaced with

$$S_{2,t-1}^d + \theta_t(M_{2,t-1}^d + q_t B_t) \geq S_{1t}^d + \theta_t M_{1t}^d \quad (41)$$

$$M_{1t}^d + p_t x_{1t} \geq M_{2t}^d + B_t \quad (42)$$

For a favorable discount ( $q > \beta$ ), a domestic agent will borrow as much as possible and borrowing constraint (39) will bind. In this case the domestic agents' first-order condition (30) becomes

$$x_1 = \begin{cases} 1, & \text{if } TR'(1) < a/\beta^* \\ [TR']^{-1}(a/\beta^*), & \text{if } TR'(1) \geq a/\beta^* \end{cases} \quad (43)$$

where  $\beta^* = \beta^*(\ell) = q\ell + \beta(1-\ell) > \beta$ . The foreign agents' problem does not change. Effectively, the availability of credit lowers domestic agents' marginal cost of producing special goods from  $a/\beta$  to  $a/\beta^*$ . An equilibrium in this case must satisfy (43) as well as the foreign agents' first-order condition and (24). Equilibria are described as

*Proposition 3.* For operating costs  $\gamma > 0$  sufficiently small, there is a continuum of steady-state monetary equilibria with exchange bank lending where

- (1) Allocations, the silver-equivalent price of special goods  $\sigma = \theta p$ , and the real stock of bank money are the same in every equilibrium;
- (2) The price of money and the money price of special goods are indeterminate as in Proposition 1;
- (3) The summer (end of period 1) nominal money stock varies with  $\theta$  according to

$$M = d_1 / \theta \quad (44)$$

where  $d_1$  is the equilibrium consumption of the general good by domestic agents;

- (4) Money is held exclusively by foreigners over the summer and domestic agents over the winter

$$M_1^y = M_2^d + qB = M; \quad M_1^d = 0; \quad (45)$$

- (5) Neither domestic nor foreign agents store silver over the winter

$$S_2^d = S_1^y = S_1^o = 0; \quad (46)$$

- (6) The exchange bank stores sufficient silver to satisfy its liquidity constraint (20)

$$S_1^b = S_2^b = \delta \underline{\theta} M = \delta (\underline{\theta} / \theta) d_1. \quad (47)$$

*Proof.* Since only the domestic agents' first-order condition (43) is modified from the previous cases, proof is by the same arguments.

Does lending by the exchange bank improve welfare? To answer this question, one must consider the capital costs of the bank's lending program. If lending leads to an increase in consump-

tion by domestic agents  $d_1$ , then from (20) the bank must hold additional capital to maintain its liquidity. As a reference case, imagine that bank's stock of silver is obtained through a one-time, lump-sum tax on domestic agents only.<sup>56</sup> The following result then applies.

*Corollary.* The monetary equilibrium with lending is inefficient. However, for operating costs  $\gamma > 0$  sufficiently small, there is some equilibrium with lending that dominates the monetary equilibrium without lending.

*Proof.* Inefficiency of the equilibrium with lending follows from the same arguments as in Proposition 1.

We now compare equilibria with lending to the equilibrium without. Again two cases must be considered. We consider the effects of a vanishingly small amount of lending (a small increase in the credit limit  $\ell$  over  $\ell = 0$ ).

Case 1.  $TR'(1) < a/\beta$ . The silver-equivalent price of special goods  $\sigma$  is equal to 1 for both the equilibrium with lending and the equilibrium without. In this case, allocations are same in both equilibria, but domestic agents produce at (effectively) a lower unit cost ( $= a/\beta^*$  with lending compared to  $a/\beta$  without). Thus, with lending, domestic agents' utility increases and the exchange bank need hold no additional silver in order to satisfy its liquidity constraint. Foreign agents' utility is unaffected. Hence lending dominates for this case.

Case 2.  $TR'(1) \geq a/\beta$ . The silver equivalent price of special goods  $\sigma$  is less than 1 in the equilibrium without lending. Then it is straightforward to show introducing lending causes both a decrease in  $\sigma$  and an increase in foreign agents' utility.

Now consider the steady-state utility of domestic agents. Using (6) this is

$$d_1 - af_2 - (1 - \beta)S_b \quad (48)$$

when the bank's silver holdings  $S_b$  are financed by a lump-sum levy on domestic agents. Using (43) and (47) rewrite expression (48) as

$$\left[1 - (1 - \beta)\delta(\underline{\theta}/\theta)\right]TR\left([TR']^{-1}(a/\beta^*)\right) - [TR']^{-1}(a/\beta^*) \quad (49)$$

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<sup>56</sup> I.e., direct taxation of foreign agents is not possible. As discussed previously, in practice the bank's capital derived at least partly from accumulated profits on lending. Obtaining capital in this way would have imposed additional costs beyond the costs of the lump-sum levy considered here, but also would have shifted some of the bank's capital costs to foreigners.

The derivative of (49) with respect to  $\ell$  is

$$-(q - \beta) \left[ 1 - (1 - \beta) \delta(\underline{\theta}/\theta) - \beta^* \right] \left( \frac{a}{\beta^*} \right)^2 \left( [TR']^{-1} \right)' \left( \frac{a}{\beta^*} \right) \quad (50)$$

whose sign varies as the sign of

$$1 - (1 - \beta) \delta(\underline{\theta}/\theta) - \beta^* . \quad (51)$$

As  $\gamma \rightarrow 0$  and  $q \rightarrow 1$ , (51) is positive iff

$$1 - \ell > \delta(\underline{\theta}/\theta) , \quad (52)$$

and, since  $\delta(\underline{\theta}/\theta) < 1$ , condition (52) must hold for  $\ell > 0$  sufficiently small. In words, domestic agents' utility is increased if lending is slightly increased from zero. Note, however, sufficiently large increases in lending  $\ell$  may decrease domestic agents' utility.

### *Discussion*

The corollary to Proposition 3 shows that lending by the AWB could have increased welfare even with a liquidity requirement such as (20). The need for substantial backing of bank money would have imposed limits on the bank's lending however. Beyond a certain point, the extra profit obtained by increasing loans to domestic agents would have been outstripped by the attendant liquidity costs. From condition (52), the liquidity constraint could have been made less binding only by lowering either the bank's "bid price" for bank money  $\underline{\theta}$  or its liquidity "comfort factor"  $\delta$ .

From the domestic agents' point of view, monopoly profits on sales of special goods would have been the necessary ingredient for their support of the banks' lending operations. With competitive pricing of the special good, lending would have provided no benefit to domestic agents and no incentive to support this activity.

### *Lending operations with receipts*

We now consider in more detail how the introduction of receipts would have impacted the bank's liquidity constraints. In the pre-receipt equilibrium with lending, the year- $t$ , beginning-of-stage 1a (after foreign agents arrive in Amsterdam but before trading) balance sheet of the bank is

Table 2: Bank's balance sheet (beginning of stage 1, without receipts)	
Assets	Liabilities + NW
Silver $S_{2,t-1}^b$	Balances $M$
Loans to domestic agents $B$	NW

and the bank's liquidity constraint would be given by (20), i.e.,  $S_{b,t-1}^2 \geq \delta \underline{\theta} M$ . After stage 1 trading (beginning of stage 2) is complete, the bank's balance sheet is

Table 3: Bank's balance sheet (beginning of stage 2, without receipts)	
Assets	Liabilities + NW
Silver $S_{1,t}^b$	Balances $M$
Loans to domestic agents $B$	NW

and the liquidity constraint is  $S_{1,t}^b \geq \delta \underline{\theta} M$ . Since  $S_{1,t}^b = S_{2,t-1}^b$  in equilibrium, the bank's liquidity constraint does not change from stage 1 to stage 2. After stage 2 trading is complete and loans are repaid, the bank's balance sheet is

Table 4: Bank's balance sheet (end of stage 2, without receipts)	
Assets	Liabilities + NW
Silver $S_{2,t}^b$	Balances $M_2^d$
	NW

The liquidity constraint at this stage is  $S_{2,t}^b \geq \delta \theta M_2^d$ , which, since  $S_{2,t}^b = S_{1,t}^b$  in equilibrium, is implied by the previous liquidity constraints.

Now consider the bank's balance sheets at the same stages under the receipt system. At the beginning of money market trading stage 1a, the bank's balance sheet is

Table 5: Bank's balance sheet (beginning of stage 1, with receipts)	
Assets	Liabilities + NW
Silver $S_{2,t-1}^b + D_1$	Balances $M$ of domestic agents
Loans to domestic agents $B$	Balances $D_1$ of foreign agents [of which $D_1$ redeemable on demand]
	NW

If the bank is only committed to pay coin against all outstanding receipts, its liquidity constraint is

$$S_{2,t-1}^b + D_1 - L_1 \geq D_1 - L_1 \quad (53)$$

or simply

$$S_{2,t-1}^b + L_1 \geq 0 \quad (54)$$

Following stage 1 trading, the bank's balance sheet is

Table 6: Bank's balance sheet (beginning of stage 2, with receipts)	
Assets	Liabilities + NW
Silver $S_{1,t}^b = S_{2,t-1}^b + D_1 - L_1$	Balances $D_1 + \lambda L_1$ of foreign agents [ $D_1 - L_1$ redeemable on demand]
Loans to domestic agents $B$	NW

If the bank is committed to pay coin against all outstanding receipts, its liquidity constraint is

$$S_{2,t-1}^b + D_1 - L_1 \geq D_1 - L_1 \quad (55)$$

or

$$S_{2,t-1}^b \geq 0 \quad (56)$$

Finally, after stage 2 trading is complete, the bank's balance sheet contracts to

Table 7: Bank's balance sheet (end of stage 2, with receipts)	
Assets	Liabilities + NW
Silver $S_{2,t}^b = S_{2,t-1}^b$	Balances $M_2^d$
	NW

Since all receipts have been redeemed by this point, there is no liquidity constraint on the bank.

To summarize, these calculations indicate that under the receipt system, an expansion of the bank's lending  $B$  need not be backed by an expansion of its silver holdings  $S^b$ , essentially because, under receipts, the bank's liquidity constraint is slackened from (47) (in its equilibrium form) to (56). Indeed, in the steady-state world analyzed here, it is conceivable that the bank holds no silver over the winter. To avoid indeterminacy of the silver price of money  $\theta$  in particular, however, we assume that the bank must commit (off-equilibrium) to sell silver (i.e., receipts) at its target price, and possess "enough" silver  $\underline{S} > 0$  to back this pledge.

This does not explain how large  $\underline{S}$  must be to guarantee determinacy. As a benchmark for the comparisons below, we take  $\underline{S}$  to be the value of  $S_2^b$  necessary to support the monetary equilibrium without lending, i.e.,  $\underline{S} = S_2^b$  as specified in (35).

Our last set of results confirms agents' preferences for the receipts arrangement:

*Proposition 4.* With receipts, the monetary equilibrium with lending  $\ell$  is identical to the equilibrium given in Proposition 3, except that the bank's winter silver stock  $S_2^b$  is reduced to  $\underline{S}$ .

*Proof.* As in Proposition 2, optimality conditions and market clearing are not affected by the introduction of receipts.

*Corollary 1.* For a given credit limit parameter  $\ell$ , the equilibrium with receipts dominates the equilibrium without receipts.

*Proof.* Decreasing the bank's winter silver holdings (as occurs with the introduction of receipts) does not change allocations of consumption goods, and lowers the deadweight loss.

*Corollary 2.* Under receipts, welfare is increasing in  $\ell$ .

*Proof.* With receipts, an expansion of lending  $\ell$  does not result in an increase in the bank's winter silver holdings  $S_b^2$ . From (47), the bank's summer silver stock  $S_1^b$  increases but this occurs through voluntary deposits by foreign agents; domestic agents bear no additional liquidity cost. Hence this cost does not enter into welfare comparisons.

Increasing  $\ell$  increases domestic agents' welfare because, from (43), this lowers their marginal costs of production, while their marginal revenue from special good sales remains the same.

Foreign agents' welfare increases as in Proposition 3; hence, total welfare increases.