Clearing vs. Leakage: Does Note Monopoly Increase Money and Credit Cycles?[+]

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The effects of note monopolisation on the amplitude of money and credit cycles are studied. Swedish bank data for 1871–1915 reveal that money cycles became smaller, but credit cycles larger, after the Bank of Sweden gained a note monopoly in 1904. At the same time, the money multiplier decreased, while the credit multiplier increased. If the central bank's reserve ratio is larger than that of the commercial banks, and if the currency-deposit ratio is sufficiently large, the leakage effect could dominate the loss-of-clearing effect (base expansion), such that the money multiplier decreases. That the credit multiplier simultaneously increased is attributed mainly to an increasing time-demand deposit ratio, which increased the credit capacity of the banking system.

Key words: Clearing mechanism, Credit expansion, Currency-deposit ratio, Fiduciary money, Free banking, Leakage, Money multiplier.
JEL codes: E32 E42 E51.

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1 Introduction

Modern fractional reserve banks can extend credit by issuing fiduciary money – payment media not covered by base money. By this power, the banking system can potentially create large swings in the volumes of money and credit. A question of longstanding controversy is this: Are money and credit cycles smaller when notes are supplied competitively by many banks, or when notes are supplied monopolistically by a central bank? Ever since the classical monetary debates of the 19th century, two views have stood opposed.

In the "free banking view", note competition is the necessary remedy against credit expansion, since the inter-bank clearing mechanism will then check the banks – banks that over-expand will suffer reserve losses in the clearing, which will rapidly force them to contract. By contrast, a note monopolist (a central bank) is not constrained by the clearing mechanism, since its demand liabilities will be treated as base money by other banks and hence be used as reserves. Money and credit cycles will therefore be larger under note monopoly.

In the opposite "currency view", the clearing mechanism cannot prevent overexpansion if the banks expand in concert, since no bank will then suffer net reserve losses in the clearing. The only automatic check against overexpansion is through leakage of reserves from the banking system – eventually, through an external drain, but also (in the case of note monopoly) arising from the public's demand for currency. Money and credit cycles will therefore be larger under note competition.[1]

Although the literature on this subject goes back over a century, it has until now been limited to theoretical speculation, with little or no empirical backing. This paper moves to fill the lacuna. In late 19th century Sweden, about 25 commercial banks called Enskilda banks issued notes, competing successfully with the Bank of Sweden, until

[1] On the classical monetary debates see Smith (1936), White (1984), Schwartz (1992), Selgin and White (1994a). On the modern controversy see Goodhart (1988), Laidler (1992), Bordo and Schwartz (1996), and Selgin (2001).

this bank gained a note monopoly in 1904. This paper uses Swedish bank data from 1871–1915 to investigate how money and credit cycles were affected by the note monopolisation. Data show that the money cycle became smaller and the credit cycle larger after the Bank of Sweden gained a note monopoly in 1904. At the same time, the money multiplier decreased, while the credit multiplier increased. These facts points to a link between the size of multipliers and the size of cycles. How did note monopolisation affect multipliers?

Note monopolisation trades loss of clearing, or base expansion, which increases the multiplier – for leakage, which decreases it. What is the relative size of the clearing and leakage effects? It is shown that if the central bank's reserve ratio is larger than that of the commercial banks, and if the public's preferred currency-deposit ratio is sufficiently large, then the leakage effect may dominate the clearing effect, such that the money multiplier (and hence the banking system's credit capacity) may decrease after monopolisation. This was the case when the Bank of Sweden gained a note monopoly in 1904. However, the credit capacity is also increased if the public's preferred time-demand deposit ratio increases. This was actually the case, and this effect dominated the other effects such that the credit multiplier increased. Thus, the multiplier analysis yielded the predictions that the money cycle should have decreased post monopolisation, while the credit cycle should have increased – a result that is consistent with data.

1 Money and credit cycles 1871–1915

This section describes the empirical evidence. Using Swedish bank data for the period 1871–1915, the amplitude of money and credit cycles before and after note monopolisation in 1904 is examined. The data are from the Summary of the Bank Reports [*Sammanfattning af bankernas uppgifter*]. These are data from the bank balance sheets collected by the Bank Supervisory Authority [*Bankinspektionen*]. For the Bank of Sweden there exists quarterly data for 1871–1877, and monthly data from January 1878. For the commercial banks there exists quarterly data for 1871–1874, and monthly data from March

1875. The transfer of the note stock of the Enskilda banks to the Bank of Sweden occurred in 1901–1904. However, since note monopoly was prescribed in the Bank Law of 1897 and the Bank of Sweden thereafter began to act like a central bank (for example by rediscounting bills of other banks), the period under study may be divided into three periods: a "note competition period" 1871–1897, a "transition period" 1897–1904, and a "note monopoly period" 1904–1915.

Problem of a small sample

Because note monopolisation occurred in 1904, Sweden is fortunate in being one of few countries where it is possible to compare the relative performance of note competition versus note monopoly in the period of the classical gold standard. Unfortunately, there were only ten years with note monopoly before the demise of the classical gold standard in 1914 at the outbreak of WWI. The cycles sample is therefore small, with three cycles in the note competition period 1871–1897, one cycle in the transition period 1897–1904, and one cycle in the note monopoly period 1904–1915. [2] Hence, it is not possible to draw definite conclusions regarding the effects of note monopolisation on money and credit cycles. There are no degrees of freedom left to control for external events, nor is it possible to perform statistical tests. The investigation should nevertheless be of value, since – to my knowledge – it is the very first empirical study of

[2] An alternative would be to extend the data set to include the period 1915–1935. Since Sweden re-adopted the gold standard in 1924–1931, one more cycle for note monopoly on gold would then be available. Calculations of cycles for this extended sample was also performed, but they are not presented here, since it is generally agreed that macro variables fluctuated more in the interwar period than they did prior to WWI, wherefore *ceteris paribus* conditions do not apply (see for example Englund *et al* 1992). The extended-sample results actually reinforce those of the smaller sample, namely that the money cycle decreased after monopolisation, while the credit cycle increased (available upon request).

how note monopoly affects money and credit cycles.[3] Although the material is insufficient for a final statement on the question of how note monopoly affects money and credit cycles, it should provide a valuable first word on it, perhaps providing groundwork for future comparisons of countries with and without note monopoly during the classical gold standard.

Methodology

To measure cycle amplitude, moving averages (of logged variables) are used. Centred 12-month moving average (MA) series are used to filter out seasonal effects, and centred 8-year moving average series are used to filter out the trend component. An 8-year period is chosen because this was the approximate cycle length (from peak to peak) over the sample period. Cycle amplitude is thus measured as follows:

Cycle amplitude = 12 month MA – 8 year MA.

Alternatively, cycles were also calculated for cycle periods of 7 and 9 years. The results were not affected (available upon request).

1.1 Money

Two measures of money are examined: notes and fiduciary money.

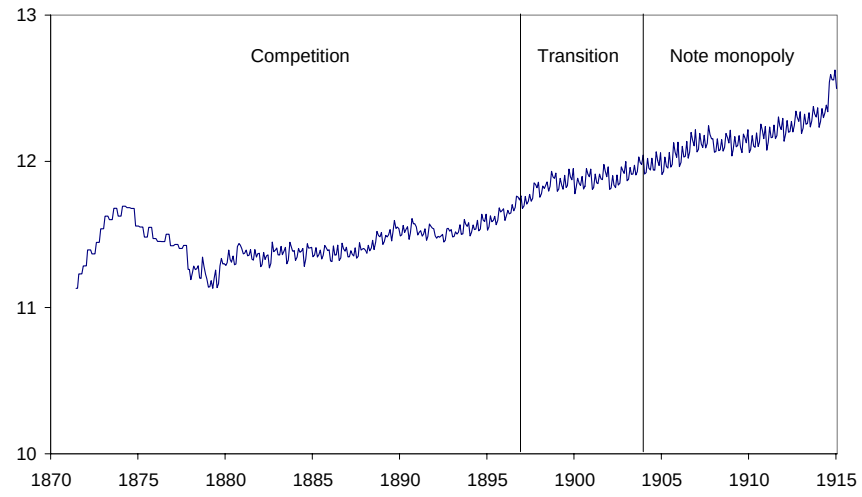
Notes include all notes issued by the Bank of Sweden and the Enskilda banks. Notes held by other banks as cash are included.

Fiduciary money include all demand liabilities used as means of payment, minus cash. *Demand liabilities* consist of notes, post bills and demand deposits held by the Bank of Sweden, the Enskilda banks and the Joint Stock banks. *Cash* includes gold, other coin, bank notes and, after January 1900, balances on giro accounts at the Bank of Sweden.

[3] Some related studies are Ögren (2003), who investigate long-term trends in money and credit in Sweden 1834–1913, and Miron (1986) and Hortlund (2005), who study the *seasonal* effects of note monopolisation in the US and Sweden, respectively.

The log of notes in 1871–1915 is presented in Figure 1. For the period 1871–1878, quarterly data are used.

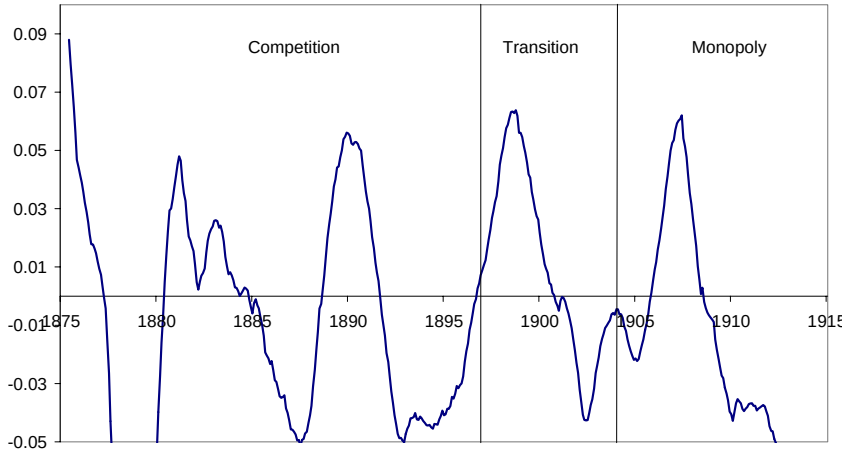
Figure 1 Log of notes of the Swedish banks, 1871–1915



Source: Summary of the Bank Reports.

There was a sharp increase in the quantity of notes in 1871–1874, in the boom years following the Franco-Prussian war. The subsequent decline could partly be due to the new bank law that was promulgated in 1874, by which Bank of Sweden notes were no longer legal tender for the note-issuing banks. Henceforth, the Enskilda bank notes were to be redeemed into gold coin only. There is also a sharp drop at the end of 1877. This drop could reflect imperfections in the data, particularly the transition from quarterly to monthly data in January 1878. The overall impression is that the note cycle did not increase after monopolisation. This is confirmed by Figure 2, which shows the cyclical component of logged notes for 1875–1915.

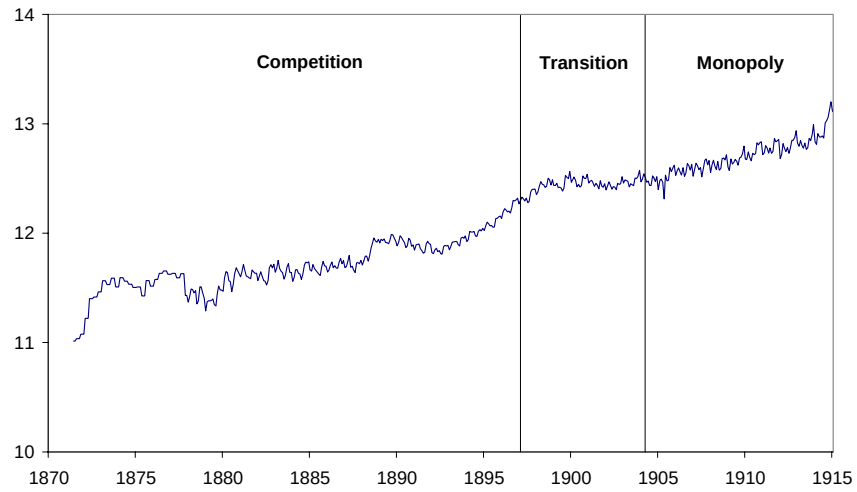
Figure 2 Cyclical component of log of notes, 1875–1915.



Source: *Summary of the Bank Reports.*
Note*: WWI cycle excluded.*

The amplitude of the notes cycle was hardly affected by note monopolisation. The three cycles before, during and after transition have amplitudes that are more or less similar. By contrast, when it comes to fiduciary money, there is a clear tendency towards a smaller cycle after monopolisation. Figure 3 shows the log of fiduciary money in 1871–1915.

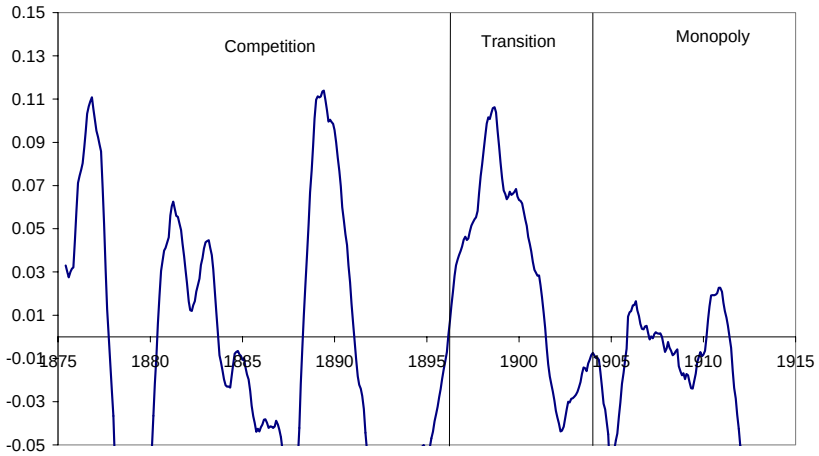
Figure 3 Log of fiduciary money, 1871–1915.



Source: *Summary of the Bank Reports.*

The period 1904–1915 is particularly interesting. In this period, a large and sharp credit cycle occurred that peaked in 1907–1908, as will be seen below. But the graph for the stock of fiduciary money is virtually flat during this period. Figure 4 confirms that the fiduciary money cycle became smaller after note monopolisation.

Figure 4 Cyclical component of log of fiduciary money, 1875–1915.

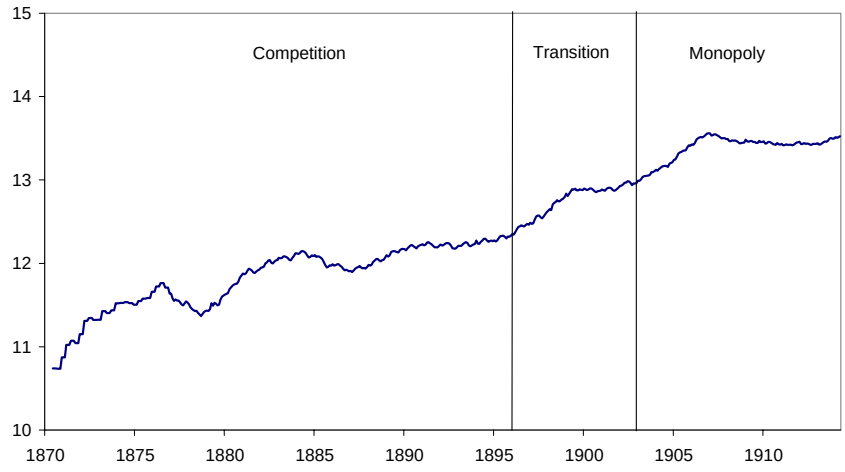


Source: Summary of the Bank Reports.

1.2 Credit

Two measures of credit are studied: bills, and total lending (bills, cash credit and loans). Bills are worth looking at separately for three reasons. First, as shown in Hortlund (2005), the discounting of bills was the main vehicle by which the commercial banks issued their notes. Second, bills were the most elastic form of credit and thus the most cyclical one. Third, the discount rate was the prime interest rate that was the benchmark for all other rates. Bills were thus the main instrument of monetary policy both before and after note monopolisation. Figure 5 shows the log of total bank bills (commercial banks plus the Bank of Sweden) in 1871–1915.

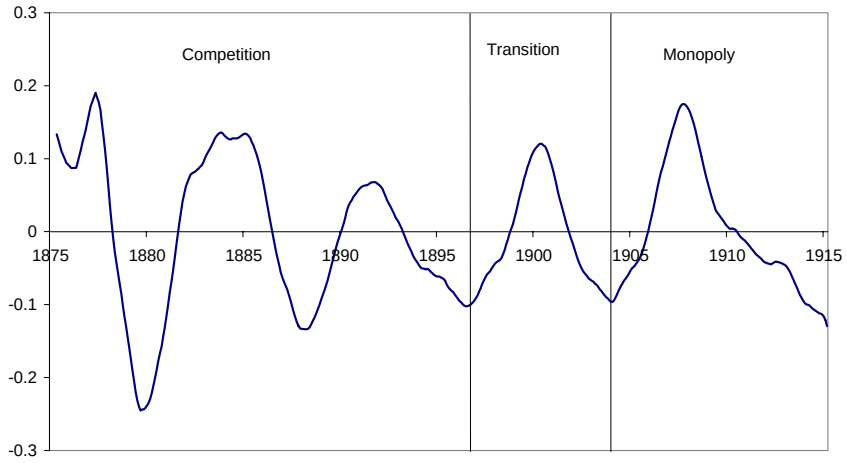
Figure 5 Log of total bank bills, 1871–1915.



Source: Summary of the Bank Reports.

The volume of bills varied cyclically with remarkable regularity. Calculation of the cyclical component indicates that the cycle amplitude increased after monopolisation. This is shown in Figure 6.

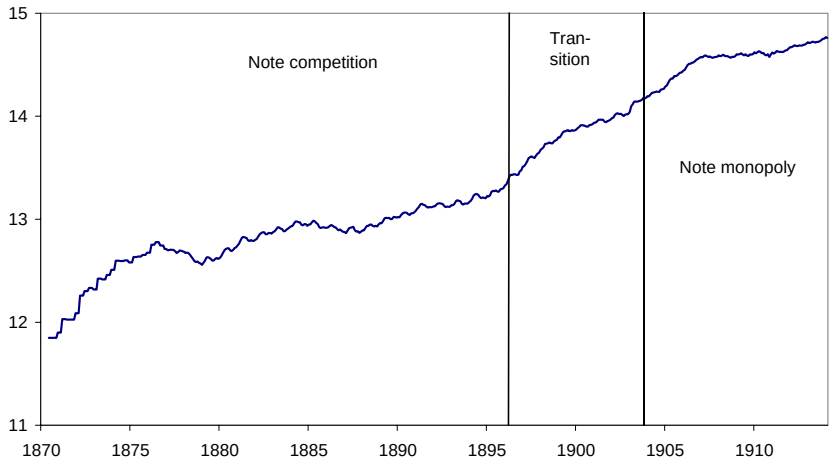
Figure 6 Cycle amplitude for log of bank bills, 1875–1935



Source: Summary of the Bank Reports.

In the competition period there is a steady downward trend in cycle amplitude. Starting in the transition period, the trend turns upwards. Compare the 1907–1908 bills cycle with the cycle of fiduciary media in the same period. Whereas the bills cycle is large and sharp, the fiduciary money cycle is virtually non-existent in this period. For total lending, the trend towards larger cycles is even more manifest. Figure 7 pictures the log of total bank lending in 1871–1915.

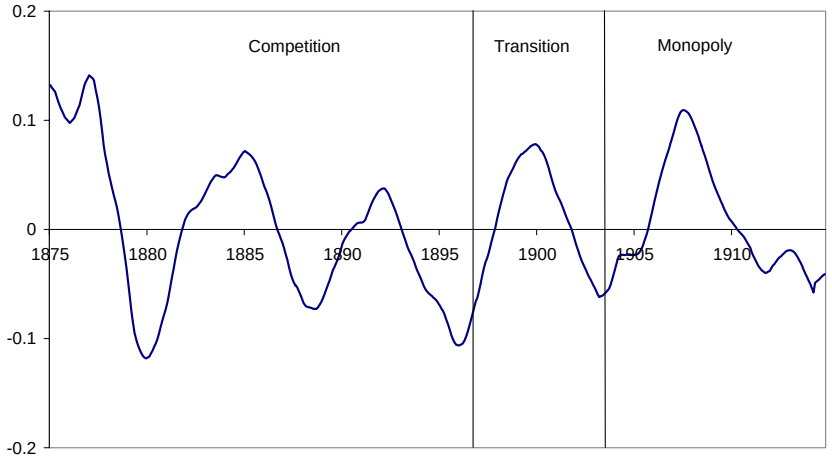
Figure 7 Log of total bank lending, 1871–1938.



Source: Summary of the Bank Reports.

Note the strong seasonality in lending during the classical gold standard period. The amplitude of the lending cycle is pictured in Figure 8. The same pattern as the one for bills is present, only even more pronounced. The tendency is for the cycle to decrease until the transition period, after which the cycle becomes larger.

Figure 8 Cyclical component of the log of lending, 1875–1915.



Source: Summary of the Bank Reports.

2 Clearing vs. Leakage: the model

The empirical evidence revealed that after note monopolisation in 1904, the money cycle became smaller, while the credit cycle became larger. This section analyses whether this result can be attributed to the note monopolisation itself. This is done by comparing money and credit multipliers before and after monopolisation. If it is the case that larger (smaller) cycles are associated with larger (smaller) multipliers, then the question of how note monopolisation affects money and credit cycles may be indirectly assessed by analysing how monopolisation affects the corresponding multipliers. Although causation from note monopolisation to cycles cannot be established by this approach, at least consistency with data can be achieved.

Following Thunholm (1962, p. 239), the "credit capacity" of the banking system is governed by two items: the quantity of precautionary reserves that banks want to hold in relation to their (demand) liabilities, and the size of the reserves leakage that arises from a credit expansion. Note monopolisation does two things. First, it withdraws the demand liabilities of the central bank from the range of the clearing mechanism. Thereby the monetary base is expanded, which enhances the credit capacity of the banking system. Second, it transforms currency into base money. This installs leakage, which constrains the credit capacity of the banking system.

If the credit capacity of the banking system can be measured by the money multiplier, it is possible to quantify the two effects. From standard textbooks (e.g. Dornbusch and Fischer 1990) we learn that the quantity of money M may be regarded as a function of the banking system's money multiplier m times the quantity of base money B. With m fixed, an exogenous change in the quantity of base money would cause a change in the quantity of money according to the expression:

$$\Delta M = m \cdot \Delta B \tag{1}$$

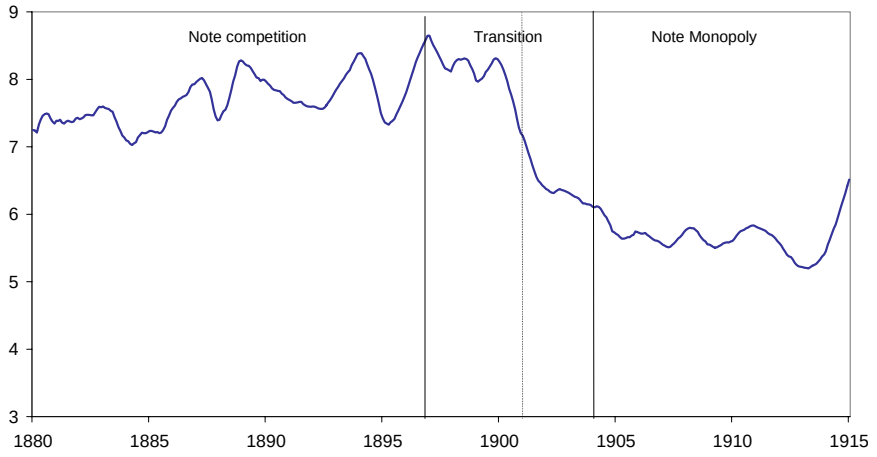
If the money multiplier were to decrease, then a given change in the quantity of base money would cause a smaller change in the quantity of money.

This kind of mechanical multiplier approach has been criticised for being unrealistic as a description of the money supply process in the real world (Goodhart 1988). Although this critique may be valid, the purpose here is not to describe the money supply process, but to use the multiplier approach as a heuristic device to convey relative magnitudes of the clearing and leakage effects. For our purpose it is enough that the following premise is reasonably valid:

> **Premise** *A larger money (credit) multiplier is associated with larger swings in the volume of money (credit).*

Intuitively, the multiplier may be regarded as a measure of how "leveraged" the fractional reserve banking system is. A larger multiplier means a larger lever, which should translate into larger swings in volumes. Indeed, this seems also to have been the case in Sweden for the period of study. Figure 9 shows the money-to-gold ratio (MGM) of the Swedish banking system, 1880–1915.

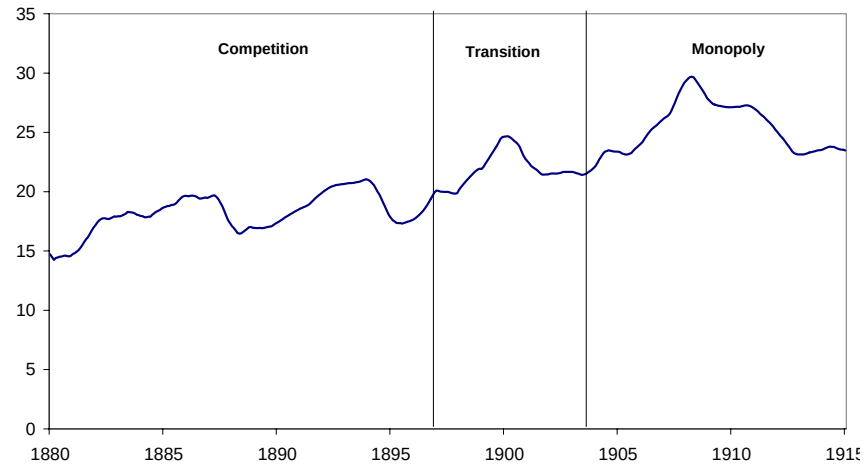
Figure 9 Money-to-gold ratio of the Swedish commercial banking system, 1880–1915.



Source*: Summary of the Bank Reports.*

The money-to-gold ratio clearly decreased after note monopolisation in 1901–1904. When it comes to the credit-to-gold ratio (CGM), the opposite tendency is present. This is seen in Figure 10.

Figure 10 Credit-to-gold ratio of the Swedish banks, 1875–1939.



Source*: Summary of the Bank Reports.*

Besides being more cyclical than the money-to-gold ratio, the credit-to-gold ratio steadily increased. In sum, there is a coincidence between the size of cycles and the size of multipliers. The money cycle decreased after note monopolisation, and the money multiplier became smaller. The credit cycle increased after monopolisation, and the credit multiplier became larger. The indirect approach is therefore warranted.

The money multiplier

In a competitive note banking system, all banks have the following schematic balance sheet:

Table 1 Bank balance sheet, note competition.

Reserves	**N**otes
Credit	**D**emand deposits
	Time deposits

The bold faced letters will be used as abbreviations. Also, subscripts "cb" and "b" will be used to distinguish variables of the central bank from those of the commercial banks. Aggregate variables have no subscript. Likewise, the prime sign will be used (when necessary) to

denote variables under note monopoly. Thus, the variable x_{cb} is a variable of the central bank in the competition period, while y_b´ is a variable of the commercial banks in the monopoly period.

The money stock M consists of notes and demand deposits. Denote inside money by I, that is, the money generated within the commercial banking system that are redeemable into base money B. In the competitive note-banking system they are notes and demand deposits. The "pure" note-competitive banking system, where no bank's demand liabilities are used as reserves by other banks, is characterised by three conditions. First, the money stock consists exclusively of inside money. Second and corollary, base money is exclusively used as reserves. Third, base money is gold G.

Conditions of the pure note-competitive banking system:

$$\begin{aligned} &1.\ I = N_b + D_b = M \\ &2.\ B = R_b = G \end{aligned} \tag{2}$$

Let us further define the following two ratios:

$$r_b = \frac{R_b}{I_b} \tag{3}$$

and

$$c = \frac{N}{D}. \tag{4}$$

That is, the reserve ratio of the banks and the currency-deposit ratio of the public. These are thought of as behavioural constants. Assume that all banks have the same reserve ratio r_b. The money-to-gold multiplier (MGM) may then be calculated as follows:

$$\frac{M}{G} = \frac{M}{B} = \frac{M}{R_b} = \frac{M}{r_b I_b} = \frac{1}{r_b}\frac{N+D}{N+D} = \frac{1}{r_b} \equiv m. \tag{5}$$

With note competition, the money-to-gold multiplier is equal to the money-to-base multiplier, or money multiplier for short. We see that the money multiplier is the inverse of the reserve ratio, a result

previously derived by Selgin (1994). The currency-deposit ratio plays no role in the money multiplier. An increase in the demand for notes relative to demand deposits would only exchange one type of inside money for another, with no effect on the total volume of money.

As previously stated, note monopolisation does two things. By giving a central bank monopoly on notes, it withdraws the demand liabilities of the central bank from the range of the clearing mechanism, wherefore its notes and demand deposits become base money. The demand deposits of the central bank become equal to the reserves of the commercial banks, R_b. Denote by R_{cb} and r_{cb} the reserves and the reserve ratio of the central bank, where $r_{cb} = R_{cb} / B$. Note monopoly is characterised by the following conditions:

Conditions of the note-monopolistic system:

1. $R_{cb} = G$

2. $B = N_{cb} + R_b$ (6)

3. $I = D_b$

We then form the money-to-gold multiplier (with prime signs on reserve ratios):

$$\frac{M}{G} = \frac{N_{cb} + D_b}{R_{cb}} = \frac{(c+1)D_b}{r'_{cb}B} = \frac{1}{r'_{cb}} \frac{(c+1)D_b}{(c+r'_b)D_b} = \\ = \frac{1}{r'_{cb}} \frac{1+c}{c+r'_b} \equiv \frac{1}{r'_{cb}} \cdot m' \tag{7}$$

The MGM of note monopoly consists of two items: the money multiplier m' of standard textbooks, divided by the central bank's reserve ratio. In contrast to the case of note competition, the money multiplier of note monopoly is affected by a change in the currency-deposit ratio. A larger c means more leakage of reserves, which forces the banks to contract. The money multiplier is therefore smaller

under note monopoly. If the MGM is to *decrease* after note monopolisation, the following must hold:

$$\frac{1}{r_b} > \frac{1}{r'_{cb}} \frac{c+1}{c+r'_b} \tag{8}$$

or

$$r'_{cb} > r_b \cdot \frac{c+1}{c+r'_b} = r_b \cdot m', \tag{9}$$

Formula (8) expresses the essential trade-off of note monopolisation. Monopolisation creates base expansion, equal to the inverse of r_{cb}. But it also installs leakage which lowers the money multiplier from m to m' (c is added to both the nominator and the denominator of $1/r_b$). We saw that the MGM actually decreased after the bank of Sweden gained a note monopoly in 1904. An intriguing question is whether this fact may be attributed to the relative size of the leakage and clearing effects. Under what conditions will the leakage effect dominate the base expansion effect, such that the money-to-gold multiplier decreases? First, consider the case when the central bank's reserve ratio is equal to that of all the other banks, and when the reserve ratio of the commercial banks is unaffected by the monopolisation. That is, we have that

$$r_{cb} = r'_{cb} = r_b = r'_b \tag{10}$$

This condition would apply for example if one bank was given a note monopoly, and this act did not alter the bank's reserve ratio. From inequalities (8) and (9) we see that m must then be equal to one if the total multiplier is to remain unchanged, or smaller than one, if the total multiplier is to decrease:

$$\frac{c+1}{c+r'_b} \leq 1 . \tag{11}$$

The money multiplier can at most be equal to one, and this occurs if the banks hold 100 percent reserves, or if c is infinitely large. In practice this never happens. This yields the following proposition:

Proposition 1 *If the central bank's reserve ratio is equal to the reserve ratio of the commercial banks, then the money-to-gold multiplier will increase post monopolisation.*

Now consider the case when the central bank's reserve ratio is different from the reserve ratio of the commercial banks, and where reserve ratios are unaffected by the monopolisation. In this case we have:

$$\begin{aligned} r_{cb} &= r'_{cb} \neq r_b \\ r &= r'_b \end{aligned} \tag{12}$$

With note competition, the money stock will be

$$M = M_{cb} + M_b = \frac{(1-a)B}{r_{cb}} + \frac{aB}{r_b}, \tag{13}$$

where a is the share of base money held by the commercial banks. For the MGM to decrease after monopolisation, the following must hold:

$$\frac{(1-a)}{r_{cb}} + \frac{a}{r_b} > \frac{1}{r'_{cb}} \frac{(c+1)}{(c+r'_b)}. \tag{14}$$

Since it is assumed that $r_{cb} = r_{cb}'$, we may solve for r_{cb} to get

$$r_{cb} > \frac{r_b}{a}\left(\frac{(c+1)}{(c+r'_b)} - (1-a) \right). \tag{15}$$

Compare (15) with (9). If a = 1, then all base money prior to monopolisation was held by the commercial banks (the central bank did not exist prior to monopolisation, or it operated with the same reserve ratio as other banks). A prominent example would be the inauguration of the Federal Reserve System in 1913. In this case, (15) reduces to (9). On the other hand, if a = 0, that is, if all base money was held by the central bank prior to monopolisation, then the right-hand side would become infinite. Since r_{cb} can at most be equal to one, this means that the MGM could not decrease after monopolisation. Thus, in order for the MGM to decrease, it is not only necessary that the central bank's reserve ratio be sufficiently large

compared to the reserve ratio of the commercial banks. In addition, the base money share of the commercial banks prior to monopolisation must be sufficiently large. Stated explicitly:

> **Proposition 2** *If the money-to-gold multiplier is to decrease post monopolisation, then (i) the central bank's reserve ratio must be higher than that of the commercial banks, and (ii) the base money share of the commercial banks prior to monopolisation must be sufficiently large.*

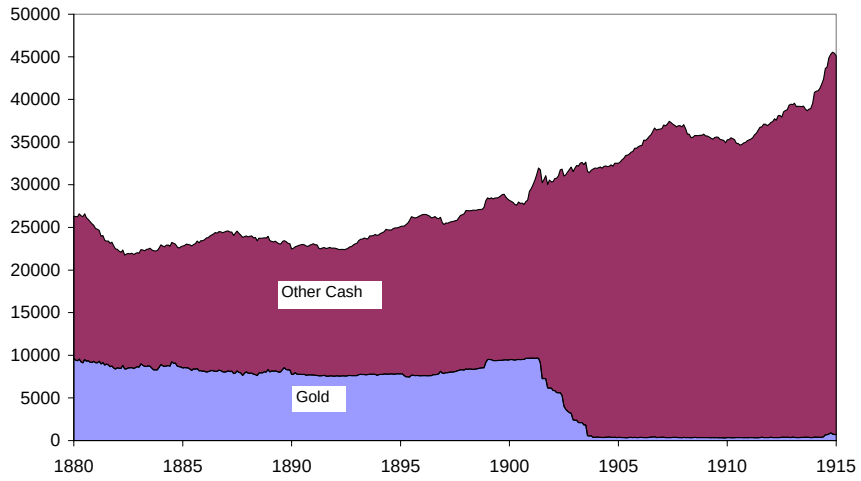
Whether the MGM will decrease or not thus depends on the numerical relation between r_{cb}, r_b, r_b', c and a, in accordance with formula (15). The multiplier will decrease more the larger a, r_{cb}, r_b' and c are, and the smaller r_b is.

The reserve role of Bank of Sweden notes

So far we have discussed a "pure" note banking system where base money is gold, and where the demand liabilities of the central bank is in no way used as reserves by other banks prior to note monopolisation. Unfortunately, this condition was not present in Sweden prior to 1901. In order to get an operational model it is necessary to discuss the reserve role of Bank of Sweden notes prior to monopolisation.

The Summary Reports report banks' cash balances under three headings: "Swedish gold coin", "Other gold", and "Silver, copper and bronze coin, and Bank of Sweden notes". The last item was changed in January 1900 to include also "Giro accounts at the Bank of Sweden". In the following, total cash balances ("Cash") will be divided into "Gold" and "Other Cash". It turns out that Other Cash for the commercial banks was quite large – about twice the amount of Gold. This is seen in Figure 11.

Figure 11 Gold and Other Cash of Swedish commercial banks, 1880–1915.



Source: Summary of the Bank Reports. Other Cash (1880–1899): "Silver, copper and bronze coin, and Bank of Sweden notes"; (1900–): also including "Giro accounts at the Bank of Sweden".

The quantity of gold held by the commercial banks was more or less constant, whereas the quantity of other cash fluctuated more. In 1901 virtually the whole gold stock was transferred to the Bank of Sweden (BoS) in exchange for giro accounts at the bank. It is probable that the major part of Other Cash consisted of BoS notes – the banks should have had little incentive to hold large quantities of coin (other than gold). This means that the Swedish note banking system was not a pure "free banking" system, and the reserve role of BoS notes will have to be incorporated into the model.

Denote by N_r BoS notes held as reserves by the commercial banks. Define $N_r = xaG$, that is, BoS notes held as reserves are said to be a fixed share of the commercial banks' gold holdings (which in the light of Figure 11 seems reasonable). Bank reserves can then be written

$$\begin{aligned} R_{cb} &= (1-a)G \\ R_b &= aG + N_r = aG + xaG = (1+x)aG \end{aligned} \tag{16}$$

The total quantity of money will then be:

$$M = M_{cb} + M_b = \frac{1}{r_{cb}} \cdot (1-a)G - N_r + \frac{1}{r_b} \cdot (aG + N_r)\,. \tag{17}$$

The BoS notes held as reserves by the commercial banks must be subtracted from the total money stock, but added to the stock of reserve money held by the commercial banks. The total money-to-gold multiplier may be written

$$\begin{aligned} \frac{M}{G} &= \frac{1}{G}\left(\frac{1}{r_{cb}} \cdot (1-a)G - xaG + \frac{1}{r_b} \cdot (aG + xaG) \right) = \\ &= \frac{(1-a)}{r_{cb}} + \frac{(1+x)a}{r_b} - xa \end{aligned} \tag{18}$$

To get the trade-off between the central bank reserve ratio and the currency-deposit ratio, we substitute (18) into (14) to get:

$$r_{cb} > H \cdot \left(\frac{(c+1)}{(c+r_b')} - (1-a) \right), \tag{19}$$

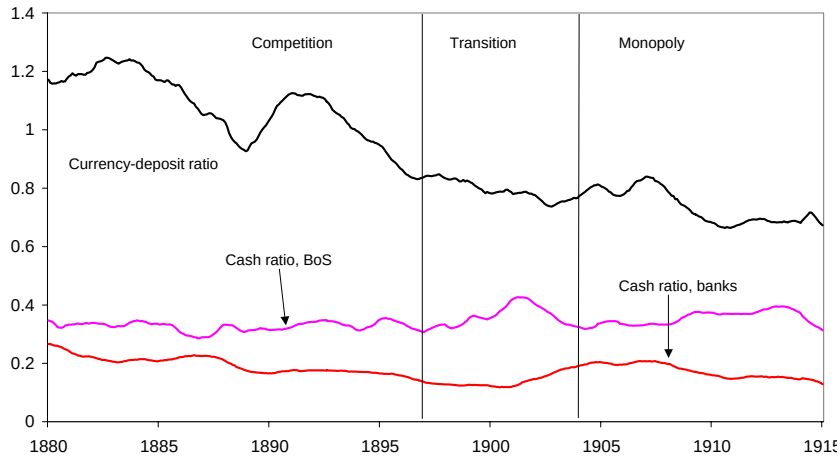
where

$$H = \left(\frac{(1+x)a}{r_b} - xa \right)^{-1}. \tag{20}$$

Formula (19) differs from (15) with regard to the constant H. If $x = 0$, then H reduces to the ratio r_b/a and (19) and (15) will be equal. However, if $x > 0$ then H will be greater than this ratio. BoS notes used as reserves increase the monetary base and hence the multiplier.

We are now ready to operationalise the model. Figure 12 shows the reserve ratios of the commercial banks and the Bank of Sweden, as well as the currency-deposit ratio, in 1880–1915.

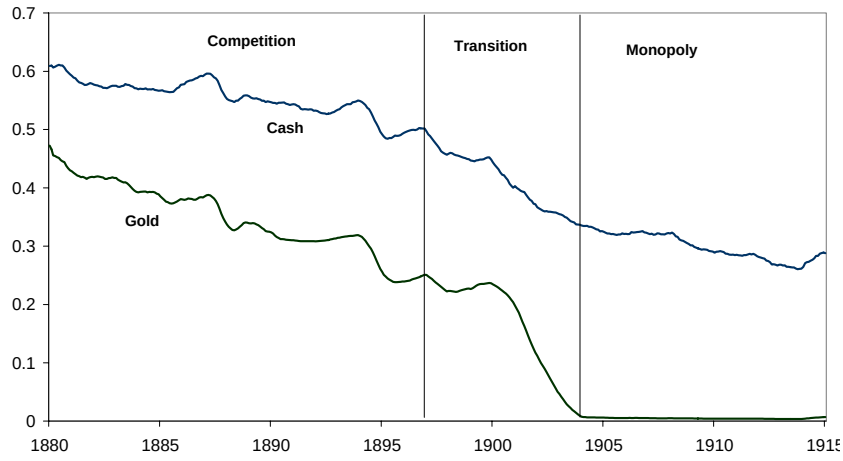
Figure 12 Reserve and currency-deposit ratios, Sweden 1880–1915.



Source: Summary of the Bank Reports.

The cash ratio of the Bank of Sweden was highly stable prior to monopolisation, about 0.33. It was not greatly affected by monopolisation. The cash ratio of the commercial banks was 0.17 at the beginning of the transition period, and 0.20 at the end of it. There is a clear increase in the ratio when notes were transferred to the Bank of Sweden in 1901–1904 – the commercial banks were thus not able fully to substitute their loss of notes for deposits. The currency-deposit ratio was about 0.8 at the time of transition, both before and after. Figure 13 shows the base money share a of the commercial banks in 1880–1915. Figures are presented both for a calculated on the basis of Gold, as well as on Cash.

Figure 13 Base money share of commercial banks, 1880–1915.

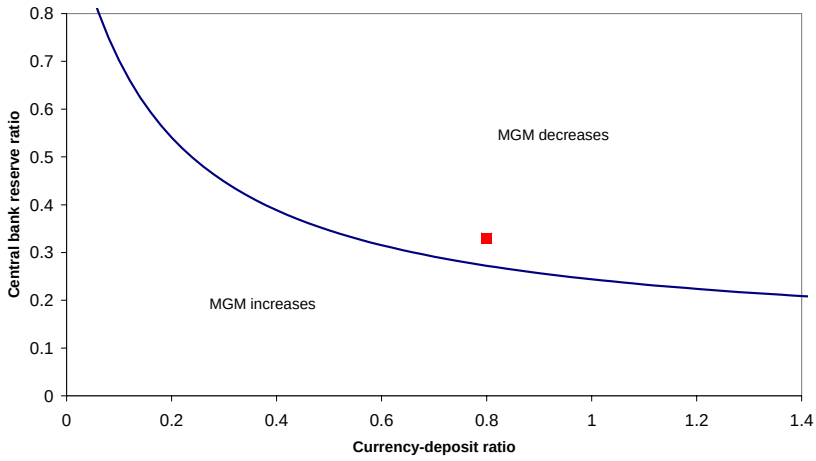


Source: Summary of the Bank Reports.

For both measures the base money share of the commercial banks tended to drop through the whole period. The share of the gold stock was nevertheless more than 30 percent until 1894, when it dropped because the Bank of Sweden increased its gold stock. It then decreased to zero in the transfer period 1901–1904.

Figure 14 depicts the essential trade-off between loss-of-clearing (base expansion), represented by the central bank's reserve ratio – and leakage, represented by the currency-deposit ratio. This trade-off is expressed by formulas (19) and (20). The parameters are: $r_b = r_b' = 0.17$, $a = 0.33$, and $x = 2$.

Figure 14 Break-even central bank reserve ratio as a function of the currency-deposit ratio.



Note: $r = r' = 0.17$, $a = 0.33$, $x = 2$.

The line represents points where (19) holds with equality. Points above and to the left of this line are combinations of r_{cb} and c where the MGM will decrease – the leakage effect dominates the loss-of-clearing effect. Conversely, points to the left of and below the line are combinations of r_{cb} and c that for current parameters will cause the multiplier to increase – the loss-of-clearing effect then dominates the leakage effect. Figure 12 shows that reasonable values for r_{cb} and c are 0.33 and 0.8. This point is marked in Figure 14, and it lies above the line. The conclusion is therefore that the MGM should have decreased post monopolisation. This is confirmed by calculating MGMs before and after monopolisation, using formulas (18) and (7). The MGM prior to monopolisation is

$$\frac{0.67}{0.33} + \frac{3 \cdot 0.33}{0.17} - 2 \cdot 0.33 = 7.2\,, \tag{21}$$

while the MGM after monopolisation is

$$\frac{1}{0.33} \cdot \frac{1.8}{0.97} = 5.6. \tag{22}$$

This is a decrease of about 20 percent, and is roughly consistent with the numbers of Figure 9.

The credit multiplier

With Thunholm it was argued that the credit capacity of the banking system was determined by the bank reserve ratio and the size of the reserves leakage that arises from a credit expansion. Hence, the credit capacity could be measured by the money multiplier. However, a third item is also of importance, namely the public's preferred time-demand deposit ratio. If the public wants to hold more time deposits relative to demand deposits, then this would enhance the credit capacity, since less demand deposits means that less reserves are tied up. The money multiplier is therefore a valid measure of the credit capacity only under the assumption that the time-demand deposit ratio remains unchanged.

To see this, we calculate the "credit multiplier" in a note-competitive banking system, in the same way as we did with the money multiplier. From the balance sheet of Table 1 we see that the credit of the commercial banks C_b is equal to

$$C_b = N_b + D_b + T_b \tag{23}$$

Define the time-demand deposit ratio t as

$$t = \frac{T_b}{D_b}. \tag{24}$$

As was the case with c and r_b, t is treated as a behavioural constant. With regard to the central bank, we assume that it does not have time deposits. Before monopolisation, the time deposits of the Bank of Sweden were small: The Summary Reports reveal that while the commercial banks had a time-demand deposit ratio of around 6 in the 1880s, the ratio for the Bank of Sweden was below 1. After monopolisation time deposits disappeared completely. The central bank's credit is therefore

$$C_{cb} = I_{cb} - R_{cb}. \tag{25}$$

Total credit may be calculated as

$$C = C_{cb} + C_b = (I_{cb} - R_{cb}) + (N_b + D_b + T_b - R_b) =$$

$$= (I_{cb} - R_{cb}) + (c + 1 + t) \cdot D_b - R_b = \tag{26}$$

$$= \left(\frac{1}{r_{cb}} - 1 \right) \cdot R_{cb} + \left(\frac{(c + 1 + t)}{r_b (c + 1)} - 1 \right) \cdot R_b$$

Using (16), the total credit-to-gold multiplier CGM becomes

$$\frac{C}{G} = \left(\frac{1}{r_{cb}} - 1 \right) \cdot (1 - a) + \left(\frac{(c + 1 + t)}{r_b (c + 1)} - 1 \right) \cdot a(1 + x) =$$

$$= \frac{1}{r_{cb}} \cdot (1 - a) + \frac{(c + 1 + t)}{r_b (c + 1)} \cdot a(1 + x) - (1 + xa) \tag{27}$$

Under note monopoly, the CGM is

$$\frac{C}{G} = \frac{C_b + C_{cb}}{G} = \frac{D_b + T_b - R_b + N + R_b - R_{cb}}{R_{cb}} =$$

$$= \frac{1}{r'_{cb}} \frac{(1 + t' + c)}{(c + r'_b)} - 1 \tag{28}$$

If the CGM is to remain constant after monopolisation, then (28) must be equal to (27). Assume that a = 1, and x = 0, that is, all base money is held by the commercial banks in the competition period (all banks are alike), and no BoS notes are held as reserves by the commercial banks. As mentioned, a good example of this situation is the one of the founding of the Federal Reserve System in 1913. In addition, under the condition that t is constant, that is, $t = t'$, then if (28) equals (27) it means that

$$r_{cb} = r_b \cdot \frac{(c + 1)}{(c + r'_b)}. \tag{29}$$

This is the same condition as the one that pertained to the MGM in (9). This means that an increase (decrease) in the MGM means an equal increase (decrease) in the CGM, and a sign that the credit capacity of the banking system has increased (decreased). By observing a decreasing money multiplier, we can predict that credit cycles should become smaller. We can state the following:

> **Proposition 3** [Prior to monopolisation the gold share of the central bank is zero, and the commercial banks do not hold central bank notes as reserves:] If the time-demand deposit ratio is constant, then a decrease in the money multiplier means a decrease in the credit multiplier, and hence a decrease in the credit capacity of the banking system.

However, in the Swedish case, a was smaller than one and x was larger than zero, wherefore Proposition 3 does not necessarily hold. Under what conditions will a decreasing money multiplier be associated with an increasing credit multiplier? This question is here addressed by means of a numerical example. The strategy is to calculate the CGM using parameter values that ensure that the MGM decreases. Could the credit multiplier simultaneously increase? The parameter values are the realistic ones that were used above: $r = r' = 0.17$, $a = 0.33$, $r_{cb} = 0.33$, $c = 0.8$, and $x = 2$. These parameters ensured that the MGM decreased. If $t = t' = 5$ (see Figure 15 below), the CGM before monopolisation becomes (by formula 27)

$$\frac{1}{0.33} \cdot 0.67 + \frac{3 \cdot 6.8}{0.17 \cdot 1.8} \cdot 0.33 - 1.67 = 20 \,. \tag{30}$$

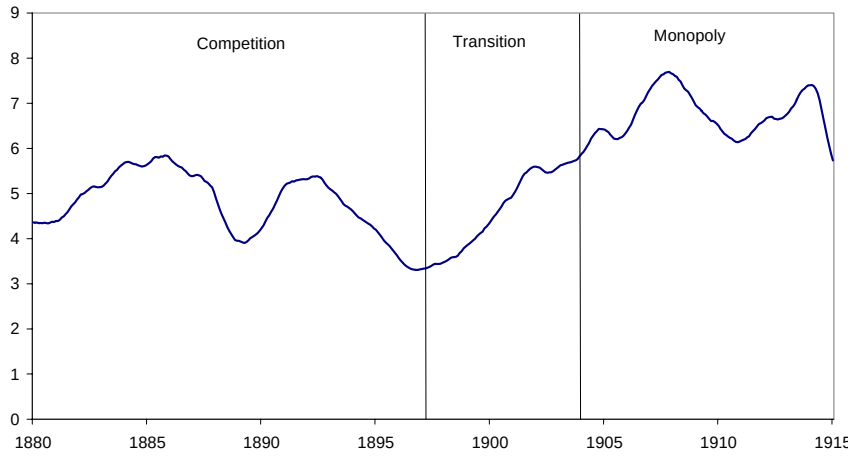
After monopolisation it becomes (by formula 28)

$$\frac{6.8}{0.33 \cdot 0.97} - 1 = 22 \tag{31}$$

While the money multiplier decreased, the credit multiplier simultaneously increased, although the latter increase is small, about 10 percent. This may be too small a number to be empirically relevant. However, the calculus was made on the assumption that the time-demand deposit ratio was not affected by the monopolisation. It

turns out that this assumption is not warranted. This is seen in Figure 15.

Figure 15 Time-demand deposit-ratio, 1880–1915.



Source*: Summary of the Bank Reports.*

Clearly, the time-demand deposit ratio increased after monopolisation, from levels around 5 in the competition period, to levels around 7 in the monopoly period. It is interesting that monopolisation was associated with such a clear increase in the time-demand deposit ratio. Calculating the post-monopolisation credit multiplier with $t' = 7$ yields a value of

$$\frac{8.8}{0.33 \cdot 0.97} - 1 = 26\,. \tag{32}$$

This represents a substantial increase in the credit multiplier, about 30 percent. As mentioned, the intuition is that an increase in the time-deposit ratio increases the credit capacity of the banking system, since less bank reserves are tied up.

3 Conclusions

This paper investigated the quantitative effects of note monopolisation on money and credit cycles. Note monopolisation

trades clearing for leakage. Loss of clearing causes a base expansion effect that increases the credit capacity of the banking system. By transforming currency into base money, monopolisation also installs leakage, which curbs the credit capacity. The relative magnitudes of these two effects were evaluated through an analysis of money and credit multipliers. Empirical evidence showed that the money cycle decreased after notes were monopolised by the Bank of Sweden in 1904, while the credit cycle increased. At the same time, the money-to-gold multiplier decreased, while the credit-to-gold multiplier increased. This opened up for an investigation of how note monopolisation affected multipliers. Three results were reached:

1. If the central bank's reserve ratio is equal to the reserve ratio of the commercial banks, the money-to-gold multiplier will increase post monopolisation.

2. If the money-to-gold multiplier is to decrease post monopolisation, then (i) the central bank's reserve ratio must be higher than that of the commercial banks, and (ii) the base money share of the commercial banks prior to monopolisation must be sufficiently large.

In addition, if it is the case that prior to monopolisation the gold share of the central bank is zero, and the commercial banks do not hold central bank notes as reserves (the Fed scenario), the following proposition holds.

3. If the time-demand deposit ratio is constant, then a decrease in the money multiplier means a decrease in the credit multiplier, and hence a decrease in the credit capacity of the banking system.

However, these conditions were not fulfilled in the Swedish case. In particular, the time-demand deposit ratio increased after monopolisation, ensuring that the credit multiplier increased while the money multiplier decreased.

Although the multiplier analysis was capable of generating theoretical results consistent with the data, the smallness of the empirical sample puts a question mark over the generality of the results. To be able to reach more definite conclusions, it would be of interest to compare money and credit cycles for countries with and

without note monopoly in the period of the classical gold standard. Hopefully, this paper has provided some groundwork for such future studies.

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