The Objectives of French Monetary Policy during the Classical Gold Standard, 1876-1913: an econometric analysis of the determinants of the Banque de France's official discount rate[1]

by
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Introduction

This paper analyses the factors which influenced the Bank of France's decisions to change the official discount rate from the beginning of 1876 to the end of 1913. Changes in the discount rate were the most important instrument of monetary policy during the classical gold standard. There were 35 changes in the official discount rate during this period[2]. A second instrument was the changes in the criteria for admission to rediscounting by commercial banks and of borrowing by the non-bank private sector which at that time had also access to Bank of France credit. The third instrument was the so-called gold devices which changed the conditions of gold imports and exports and hence the width of the band around gold parity within which the market exchange rate could fluctuate.

For the period 1880-1913 Bloomfield (1959) showed that there was an inverse relationship between annual discount rates and liquidity ratios for a large number of gold standard Central Banks. Goodhart (1972) used a more sophisticated approach to study the link between the official discount rate of the Bank of England and her liquidity ratio. Using monthly data from 1891 to 1914 he regressed the level of the discount rate on her liquidity ratio, the lagged discount rate and seasonal dummy variables. He confirmed Bloomfield's result about the negative relationship. His explanation of this negative correlation was that as the liquidity ratio was falling, the Bank of England became more concerned about maintaining convertibil-

[1] This paper is based on a Laurea Dissertation presented on July 7, 1997 by Paola Zotti at the Università di Brescia entitled "Un'analisi delle determinanti del tasso di sconto in Francia durante il tallone aureo: 1876-1914" and written under the supervision of the first author. We thank Hannah Nielsen for research assistance.

[2] The discount rate changes were 221 in Great Britain, 136 in Germany and 50 in Austria-Hungary.

ity and would thus increase the discount rate to attract gold from internal circulation and from abroad.

Sommariva and Tullio (1987) analysed the factors which influenced the Reichsbank's decisions to change the official discount rate from 1876 to 1913 using for their econometric analysis data which refer to each discount rate change enacted by the Reichsbank and contained in a rather rare volume published in 1925 in Berlin by the German Imperial Printing Office and entitled "Vergleichende Notenbankstatistik" (henceforth VN). This data, which had never been used before, cover four gold standard countries (Germany, the United Kingdom, France and Austria-Hungary) using the same criteria for all four countries and contain, besides discount rates and liquidity ratios, also data on private (commercial bank's) discount rates and exchange rates. Sommariva and Tullio (1987) found, like Goodhart (1972) for the Bank of England, that the Reichsbank reacted negatively and with a lag to changes in the liquidity ratio, which implies that its main objective was to maintain internal convertibility of notes issued into gold[3].

In this paper on the French official discount rate we go several steps further with respect to the above mentioned literature. *First*, we estimate a more complete reaction function of the Bank of France which includes, in addition to the liquidity ratio, also foreign discount rates and deviations of the market exchange rate from gold parity. This will tell us how important was the objective of keeping the market exchange rate within the gold points. In addition the estimates will show to what extent the Bank of France was influenced by foreign discount rate changes and how high was the degree of international financial market integration.

Second, instead of using annual or monthly data we use the data published in VN. The main advantages of using this data are that they are available for the whole period from 1876 to 1913, that the problems of reverse causation are avoided because of the way the data are defined and constructed[4]. *Third*, we study the stability of the reaction functions over time and this will give us interesting insights into changes in the working of the gold standard from 1876 to 1913.

Fourth, we also address the question of whether the Bank of France reacted with different intensity to changes in the liquidity ratios and in the foreign variables in times of stress

[3] The conclusion that the main objective of the Bank of England and of the Reichsbank was to keep internal convertibility of banknotes outstanding should not come as a surprise: if the Reichsbank managed to keep internal convertibility of its banknotes for over 38 years, and the Bank of England for even longer, it is rather obvious that this objective must have been very important for them.

[4] Since we have the same data set for four gold standard countries we could also make meaningful international comparisons.

and ease. The idea being that if the Banque de France was interested in accumulating gold as a long run policy it would react more aggressively to decreases in reserves than to increases. Despite the fact that our model is of a very short run nature, tests of asymmetry of this type allow us to say something about the potential undermining of the long run stability of the system on the part of Banque de France. From 1880 to 1913 the gold stock of the Banque de France increased by a factor of 4.7 while the one of the Bank of England increased only by a factor of 1.3[5].

The paper is structured as follows: Section 1 presents the model explaining the changes of the Bank of France's discount rate, taking into account international influences including the state of the foreign exchange market. Section 2 describes the data used and how the variables have been constructed. Section 3 presents the estimates, the stability tests and the asymmetry tests of the reaction function of the Bank of France. Section 4 concludes.

1 The model

Following Bloomfield (1959), Goodhart (1972), Sommariva and Tullio (1987) and Contamin and Denise (1999) we present in this section a model of the Bank of France's reaction function.

The changes in the official discount rate of the Bank of France are assumed to depend on changes of its liquidity ratio. However, in order to verify the the assumption of multipolarity of the gold standard as suggested by Eichengreen (1992) and Tullio and Wolters (1996) and to measure the degree of international financial market integration a set of variables capturing international influences (exchange rates and foreign official discount rates) were included in the equation.

Thus the changes in French official discount rate (Δi^F) are assumed to depend on the level of the narrowly or broadly defined liquidity ratio (l_i), on its changes (Δl_i) (where $i=1$ for the narrow and $i=2$ for the broad one), on the changes in the official discount rates in Great Britain (Δi^E), Germany (Δi^D) and Austria-Hungary (Δi^A) and finally on the percentage deviation of the exchange rates of the French Franc with the British pound, the Reichsmark, and the currency of the Austro-Hungarian empire from their respective gold parity $w^j = (e_j - e_j^*)/e_j^*$, where j=E,D,A. The gold parity e_j^* never changed during the whole

[5] During the same period the gold stock of the Banque de France increased from 42.5 to 64.5% of the combined gold stock of the Bank of England, the Reichsbank and the Banque de France while the one of the Bank of England fell from 41.1 to 17.3%. As a share of exports the gold stock of the Banque de France increased from 56.6 to 61.5% and the one of the Bank of England fell from 12.5 to 8.6%.

period for the United Kingdom, France and Germany. The situation was more complex for Austria-Hungary which was on a silver standard until March 1879, had a paper currency not convertible into gold until 1902 with its value fluctuating within a range of about 15% from 1876 to 1894, 5% between 1895 and 1901 and moved to the classical gold standard with internal convertibility only in 1902. After that date the exchange rate fluctuated within a band of about 1.3%.[6]

The equation to be estimated is:

$$(1) \qquad \Delta i^F = a_1 + a_2 \Delta l_i + a_3 l_i + \sum_j a_{4,j} \Delta i^j + \sum_j a_{5,j} w^j + u$$

where $i = 1,2$; $j = (E, D, A)$ and Δ stands for a change of the variable. In this case Δ does not denote the usual difference operator, since in our data set the changes refer to differently spaced time points. The residuals are denoted by u.

In estimating equation (1) two different definitions of the liquidity ratio have been used, the first is the ratio of the gold and silver stock of the Bank of France to banknotes issued (l_1), and the second has the same numerator but includes in the denominator sight liabilities in addition to banknotes issued (l_2). By comparing the goodness of fit and the stability of the estimated regressions we will be able to make some inferences about which ratio may have been of greater importance to the Bank of France.

The expected signs of the coefficients of the explanatory variables are: positive for the changes in foreign official discount rates, negative for the level of the liquidity ratio, negative for the changes in the liquidity ratio and positive for the deviation of the exchange rate from gold parity. The exchange rate is defined as the number of domestic currency units for one foreign currency unit (Pound, Reichsmark, Austrian Florin/Krone); hence an increase in e_j indicates a devaluation of the French Franc (capital and gold outflows from France).

For the exact definition of the variables and for the time span to which their changes refer see Section 2. Suffice to mention here that the series used are not equidistant time series but they refer to timely ordered episodes of all official discount rate changes which occurred during the period.

The level of the liquidity ratio has been introduced into the equation in order to verify whether at high levels of gold reserves the Bank of France was reacting less than at low levels

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[6] On monetary developments in Austria-Hungary during the classical gold standard see Flandreau (1999).

to a fall in the liquidity ratio and to changes in foreign explanatory variables. This is admittedly a first rather crude test of asymmetric behaviour.

Changes in foreign discount rates are measured over a similar interval chosen by the compilers of the tables of VN to measure changes in liquidity ratios. While for France the reference interval to measure changes in the liquidity ratios generally ends on the day of the discount rate change, the interval to measure changes in the foreign discount rates ends one day before. The fact that same-day changes in the discount rates have been excluded by construction should eliminate or at least reduce problems of reverse causation in the estimated equations. The exact definition of the reference intervals is discussed in Section 2.

Equation (1) can be considered a reaction function of the Bank of France distinguishing between three objectives of monetary policy: the objective of keeping internal convertibility of outstanding banknotes into gold or silver, the objective of keeping exchange rates within the gold points and a third objective, not completely independent from the other two, of acting defensively to changes in foreign discount rates. Concerning the latter objective one should keep in mind that movements in opposite directions of the official discount rates within one month were rare during the period. There were 11 such changes between London and Berlin, 2 between London and Paris and 2 between Paris and Berlin[7].

Reaction functions of Central Banks estimated for the post World-War II period usually include inflation, unemployment or deviation of real GDP from trend or from potential GDP[8]. However, the classical gold standard was a different time when national account data were not available, unemployment was not a major issue and concerns about financial stability probably prevailed over those about the business cycle. As a result this difference in the specification of the reaction functions of Central Banks between then and now seems perfectly justified by the different historical background of the two periods.

2 Description of the data used.

The data used in this paper are obtained from VN. This two volume publication contains monthly and annual financial data for seven European countries: Austria-Hungary, Belgium, France, Germany, Holland, the United Kingdom and Russia. For four countries: France, Germany, the United Kingdom and Austria-Hungary there are more detailed tables containing a wealth of data relating to each official discount rate change. For France the relevant table is Table 134 (pages 246 and 247 of Vol. 2). The columns of this table used in

[7]See Tullio and Wolters (1996).

[8]This approach has become popular as the so called Taylor rule, especially since the work by Taylor (1993).

the empirical work are reproduced here as Table 1 to facilitate the description of the data. The numeration of the columns is retained from the original table of VN. We do not translate the headings from German because the explanation which follows should make the contents of the columns sufficiently clear.

The one and a half page long introduction to this set of tables cantains the following sentence: "These tables represent an attempt to explain with a purely numerical methodology those factors taken into consideration in deciding changes in the discount rate at the time the changes were enacted. These factors were the balance sheet of the Central Bank on the days prior to the change, confronted with another balance sheet chosen on purpose *by the compilers of the table* (italic our addition), the foreign exchanges and some foreign discount rates" (VN, page 238). This sentence and the data description which follow go a long way in explaining what the German compilers were aiming at. They certainly knew very well, long before these concepts became current, what a reaction or an objective function of a Central Bank is.

The first four columns define each episode of change in the official discount rate:

Column 1 reports the year of the change,

column 2 reports the day and month of the change,

column 3 reports the discount rate before the change,

column 4 reports the discount rate after the change.

The official discount rates reported in column 4 minus the one reported in column 3 is the dependent variable of equation (1) (Δi^F).

Column 5 contains the final day of the reference interval over which changes in the liquidity ratios are measured[9].

Column 6 contains the initial day of the reference interval, a date preceding the discount rate change by one week to five months.

The compilers were interested in eliminating disturbances caused by seasonal factors or special events. It is at these two dates that the items of the balance sheet of the Bank of France are recorded in the succeeding columns. The choice of these two dates and hence of the interval between them was made by the compilers of the tables and may have been based on the knowledge of the daily statements actually used by the Board of Directors to decide changes in the discount rate[10]. For the whole period the average interval between the two statements

[9] For France this final day coincides with the day of the discount rate change in 33 out of 35 cases.

[10] We hasten to add that this is our own supposition.

was 57.4 days. It increased from 54 days in the period 1876-1895 to 62.7 days in the period 1896-1913[11].

Table 1-Partial Reproduction of Table 134 of VN

Der Diskontsatz der Bank von Frankreich wurde verändert				A. Hauptposten des Status der Bank von Frankreich: Ausweise wurden herangezogen		Deckungsverhältnisse Deckung					B. Wechselkurse in Paris[1] am Tage vor der Diskontveränderung				C. Diskontsätze am Tage vor der Diskontveränderung				
						der Noten gegen													
						Metall		Gold	der Noten und sonstigen täglich fälligen Verbindlichkeiten gegen Metall										
Jahr	Tag	von	auf	a. für die Berechnung der Diskontveränderung maßgebend vom	b. zum Vergleich, um die Statusveränderung zu kennzeichnen vom	nach Spalte 5	+ oder − gegen Spalte 6	nach Spalte 5	nach Spalte 5	+ oder − gegen Spalte 6	Check London Frs. für 1 £	3 Monate Berlin[2] Frs. für 100 ℳ	3 Monate Wien[2] Frs. für 100 Kr.	3 Monate Amsterdam[2] Frs. für 100 hfl.	Deutsche Reichsbank	Bank von England	Österreich-Ungarische Bank	Privatdiskont an der Pariser Börse[3]	Spannung zwischen Spalte 22 und 24
		Prozent				Prozent									Prozent				
1	2	3	4	5	6	20	21	22	23	24	25	26	27	28	29	30	31	32	33
1876	26. Mai	4	3	25. Mai	6. Jan.	82,7	+ 15,2	—	67,3	+ 10,4	25,23	—	—	—	3½	3	4½	3	- 2
1877	5. April	3	2	5. April	4. Jan.	87,0	+ 5,8	—	72,5	+ 4,9	25,16	—	—	—	4	2	4½	1½	−1½
1878	16. Okt.	2	3	17. Okt.	29. Aug.	80,7	— 5,3	—	69,6	— 3,1	25,325	—	—	—	5	6	4½	2½	+ ½
1879	23. Mai	3	2	23. Mai	2. Jan.	102,1	+ 13,3	—	78,5	+ 9,0	25,195	—	—	—	3	2	4	1½	−1½
	23. Okt.	2	3	23. Okt.	21. Aug.	95,0	— 10,4	—	68,8	— 6,8	25,28	—	—	—	4½	2	4	2½	+ ½
1880	1.April	3	2½	1. April	2. Jan.	92,8	+ 8,8	36,2	71,4	+ 7,3	25,27	—	—	—	4	3	4	2½	— ½
	14. Okt.	2½	3½	14. Okt.	26. Aug.	79,5	— 10,9	35,9	69,4	— 4,6	25,330	—	—	—	5	2½	4	3	+ ½
1881	25. Aug.	3½	4	25. Aug.	23. Juni	73,9	— 1,5	24,7	54,0	— 1,3	25,27	—	—	—	4	3	4	3½	+ ½
	20. Okt.	4	5	20. Okt.	25. Aug.	66,2	— 7,7	22,1	49,6	— 4,4	25,32	—	—	—	5½	5	4	4½	+ ½
1882	23. Febr.	5	4½	23. Febr.	5. Jan.	70,6	+ 8,2	23,8	48,6	+ 0,8	25,29	—	—	—	5	6	4	3½	—1½
	2. März	4½	4	2. März	5. Jan.	70,9	+ 8,5	30,0	49,9	+ 2,1	25,275	—	—	—	5	5	4	3½	—1½
	23. März	4	3½	23. März	2. März	75,7	+ 4,8	32,5	54,0	+ 4,1	25,285	—	—	—	4	4	4	2½	—1½
1883	22. Febr.	3½	3	22. Febr.	18. Jan.	74,1	+ 5,1	35,3	58,5	+ 2,0	25,235	—	—	—	4	3½	4½	2½	—1½
1888	16. Febr.	3	2½	16. Febr.	5. Jan.	83,5	+ 2,9	40,4	69,4	+ 2,6	25,27	—	—	—	3	3	4	2½	— ½
	13. Sept.	2½	3½	13. Sept.	23. Aug.	90,3	— 1,6	42,2	70,4	+ 0,7	25,415	—	—	—	3	3	4½	3	+ ½
	4. Okt.	3½	4½	4. Okt.	15. Sept.	88,0	— 2,3	40,7	68,7	— 1,7	25,405	—	—	—	4	4	4½	3½	+ ½
1889	10. Jan.	4½	4	10. Jan.	3. Jan.	81,1	+ 0,4	36,5	65,1	+ 1,2	25,30	—	—	—	4½	5	4½	3½	—1
	24. Jan.	4	3½	24. Jan.	3. Jan.	81,5	+ 0,8	36,6	66,7	+ 2,8	25,285	—	—	—	4	4	4½	2½	—1½
	7. Febr.	3½	3	7. Febr.	31. Jan.	81,7	+ 2,8	36,8	67,7	+ 2,7	25,275	—	—	—	3	3	4	2½	—1
1892	19. Mai	3	2½	19. Mai	7. April	90,6	+ 4,7	49,2	73,8	+ 2,6	25,175	—	—	—	3	2	4	1	—2
1895	14. März	2½	2	14. März	3. Jan.	94,2	+ 4,4	59,6	80,1	+ 4,5	25,255	—	—	—	3	3	4	1½	—1
1898	20. Okt.	2	3	20. Okt.	25. Aug.	83,0	— 7,1	49,8	67,6	— 4,9	25,325	122⁹/₁₆	104	207	5	4	4½	2	—
1899	7. Dez.	3	3½	7. Dez.	24. Aug.	77,7	— 8,5	48,0	64,5	— 6,8	25,29	122⁹/₁₆	103½	207	6	6	6	3	—
	21. Dez.	3½	4½	21. Dez.	24. Aug.	77,5	— 8,7	47,9	63,8	— 7,5	25,375	122⁹/₁₆	103⁹/₁₆	207	7	6	5½	3½	—
1900	11. Jan.	4½	4	11. Jan.	4. Jan.	73,8	+ 1,5	45,9	61,9	+ 1,7	25,215	121½	102½	206½	7	6	5½	4½	—
	25. Jan.	4	3½	25. Jan.	4. Jan.	75,1	+ 2,8	46,9	63,3	+ 3,1	25,19	121½	102½	206½	6	4½	5	4	—
	25. Mai	3½	3	25. Mai	4. Jan.	79,6	+ 7,3	50,7	67,5	+ 7,3	25,175	121½	102½	205½	5½	3½	4½	3½	— ½
1907	21. März	3	3½	21. März	21. Febr.	75,8	— 0,7	55,1	65,7	— 0,3	25,33	122⁹/₁₆	103½	206½	6	5	4½	3	—
	7. Nov.	3½	4	7. Nov.	22. Aug.	74,3	— 7,9	55,5	64,3	— 5,6	25,19	122½	104½	207½	6½	6	5	3½	—
1908	9. Jan.	4	5½	9. Jan.	2. Jan.	72,0	+ 1,1	53,7	62,9	+ 1,8	25,165	122½	104½	207¹⁵/₁₆	7½	6	6	3½	— ½
	23. Jan.	3½	3	23. Jan.	2. Jan.	73,6	+ 2,7	54,9	64,6	+ 3,5	25,175	123	104½	208½	6½	5	5	3½	— ½
1911	21. Sept.	3	3½	21. Sept.	17. Aug.	75,2	— 5,2	59,5	65,9	— 3,8	25,195	123⁹/₁₆	104½	208½	5	3	4	3½	+ ½
1912	17. Mai	3½	3	17. Mai	4. Jan.	77,7	+ 8,3	62,1	67,3	+ 6,6	25,225	123½	104½	209½	5	3	5	3½	— ½
	17. Okt.	3	3½	17. Okt.	22. Aug.	73,2	— 8,1	59,4	62,2	— 5,3	25,245	123	104½	209	4½	4	5	3½	+ ½
	31. Okt.	3½	4	31. Okt.	22. Aug.	70,3	— 11,0	57,0	59,0	— 8,5	25,235	122½	104½	208½	5	5	5½	3½	—

The explanatory variables of equation (1) are obtained from Table 134 of VN as follows:

(a) Δl_1 is obtained from column 21. This liquidity ratio is defined as the ratio of the gold and silver stock to banknotes issued by the Bank of France. The change refers to the interval between the dates shown in columns 5 and 6.

[11] These sub-periods are the same considered by Sommariva and Tullio (1987) in their study on the Reichsbank.

(b) Δl_2 is obtained from column 24. This ratio is defined as the ratio of the gold and silver stock to short term liabilities (banknotes issued plus sight liabilities) of the Bank of France. Again the change is measured between the two dates shown in col. 5 and 6.

(c) l_1 is obtained from column 20: it is the level of the first liquidity ratio with reference to the date reported in column 5.

(d) l_2 is obtained from column 23.

The percentage deviations of the market exchange rate of the French Franc with the British Pound, the Reichsmark and the Austro-Hungarian currency $w^j = (e_j - e_j^*)/e_j^*$ with respect to gold parities were obtained as follows: Table 134 reports the market exchange rates of the Franc with respect to the three currencies on the day preceding the change in the official discount rate:

(e) Column 25 reports the number of Francs per Pound in London for the whole period,

(f) column 26 reports the number of French Francs for 100 Reichsmarks in Berlin; however, this series is not available from 1876 to 1895 which implies that we could only test for its significance in the second period. In addition it is a 3-months forward rate. For these two reasons this variable was not used in estimation;

(g) column 27 reports the number of French Francs per 100 Austro-Hungarian Kronen in Vienna; also this series is available only for the second period. In addition it is a 3-months forward rate. For these two reasons this variable was not used in estimation.

To obtain the explanatory variables used in the regressions the difference between the market exchange rate and the gold parity was expressed in percent of the gold parity[12].

(h) Turning to the changes of the official discount rates in Great Britain (Δi^E), Germany (Δi^D) and Austria-Hungary (Δi^A) which appear as explanatory variables, the information contained in Table 134 is not sufficient to construct these series. For its construction we had to use information contained in other tables of VN. As for these three foreign countries VN contains daily figures of the official discount rate for the whole period 1876-1913, we calculated for each of the 35 episodes of changes in the Bank of France's discount rate the corresponding changes in the three foreign official discount rates with reference to the interval between the date given in column 6 and the day before the discount rate change (see columns 29-31 of Table 1).

[12]The values of the gold parities used are the following: French Francs per Pound=25.225, Francs per 100 Reichsmarks=123.456, Francs per 100 Austro-Hungarian Kronen after 1895=105.026 (before 1896 there was no central parity). These parities are obtained from Gallarotti (1995).

Thus same-day changes in foreign official discount rates are excluded by construction. In the case of same-day changes we do not know exactly which Central Bank made the first move. However, from the minutes of the meetings of the Board of the Banque de France (Conseil Géneral) we know that on five or six occasions the Governor read a telegram from London, usually at the very beginning of the meeting, announcing a change in the Bank of England's discount rate and that a (same-day) change in the Banque de France's discount rate was decided. On one occasion (August 25, 1881) the Governor even pointed out that an increase in the French discount rate was not justified by the observed changes in the balance sheet items of the Bank, a fact fully confirmed by our data. The Conseil Genéral decided nevertheless to go ahead with the increase. In cases like these the order of causality can be established.

To summarize five observations are in order. *First*, the data presented in Table 134 can be divided into three main categories. (A) Information on the balance sheet items of the Central Bank, in other words on the assets and liabilities. (B) The market exchange rates with reference to the three main foreign currencies on the day preceding the change in the discount rate. (C) The official discount rates in Great Britain, Germany and Austria-Hungary on the day preceding the change in the official discount rate.

Second, the series contained in each column are not equally spaced chronologically ordered data; hence the frequency of the data is variable depending on the time elapsed between one discount rate change and the next. *Third*, there is virtually no degree of discretion on our part in the way the series are constructed. How the variables are constructed follows logically from a careful analysis of Table 134. *Fourth*, the compilers of the table were not just statisticians, they were economic historians writing a history of the gold standard in numbers. We presume that they must have had substantial inside information on how decisions were taken and on how the system was actually working. They may have written the book with some degree of longing for stability in international monetary matters which in 1925 was nowhere near in sight. They may have written it with the same spirit which guided Egyptian scholars in the third and second centuries BC to write down as much as they could about a disappearing culture[13].

Fifth, it is clear that the use of annual data, as for example in Bloomfield (1959), hides a substantial amount of information and certainly entails problems of reverse causation between changes in the discount rate and changes in the liquidity ratio. This may hold also for monthly data, albeit to a much smaller degree. Our data are not subject to this criticism.

[13]Most of the written Egyptian documents concerning the Egyptian culture date from these last centuries.

3 The foreign and domestic determinants of the Banque de France's discount rate, 1876-1913.

In this section we present ordinary least squares (OLS) estimates[14] of equation (1), which explains the objectives of French monetary policy during the classical gold standard and can therefore be considered a reaction function of the Banque de France. The main purposes of estimating this equation are *first* to investigate the hypothesis that changes in the liquidity ratios were the main determinants of changes in the official discount rate and hence to verify the importance for French monetary authorities of maintaining internal convertibility, *second* to investigate to what extent French monetary policy was subject to influences from abroad, *third*, which foreign countries had the greatest influence on French monetary policy, *fourth*, if the reaction function estimated is stable over time and *fifth*, whether the reaction to all explanatory variables was asymmetric or not.

Our "not equally spaced chronologically ordered data" exclude by construction all episodes on which the balance sheet of the Bank, the situation of foreign exchanges and recent changes in foreign discount rates were analysed and the decision was taken *not to change* the discount rate. This exclusion may lead some people to believe that the coefficients we estimate are biased. The question is: biased with respect to what? For instance in equation (1) the estimated coefficient of changes in the liquidity ratio is certainly higher in absolute value than in the case we had used equally spaced data. However, we simply do not have such data. On the other hand comparing the alleged bias in the coefficients estimated in this paper with coefficients estimated using for example monthly data is wrong first because our data is of a different nature and second because the coefficients estimated with monthly data may be strongly biased towards zero, especially if a large proportion of the changes in the discount rate occurred at the beginning of the month and if the gold stock of the Central Bank changed significantly within the month in the expected direction as a result of the change in discount rate itself.

The estimates are presented in Table 2. We started estimation by introducing as foreign variables all three foreign discount rate changes and the exchange rate of the Pound because this is the only exchange rate available for the whole period. We then eliminated successively those variables which were not statistically significant.

The level of the liquidity ratios and the changes in the German discount rate were never significant. From the estimates contained in Table 2 we see that the coefficients of changes in both liquidity ratios have the expected negative sign and are significantly different from zero

[14]Computations are done with EVIEWS 4.0.

at a confidence level of less than 1%. This implies that the maintenance of internal convertibility was the main objective of French monetary policy. The estimated coefficients imply that a reduction of one percentage point in the liquidity ratios led on average to an increase in the official discount rate of 6 to 10 basis points, depending on the liquidity ratio used and the specification of the equation.

Moreover, the coefficient of the deviation of the Pound from gold parity has the expected positive sign and is significantly different from zero at the 1% level. It implies that a one percentage point depreciation of the Franc led to an increase in the discount rate of 100 to 120 basis points, depending on the regression. A depreciation of the Franc must have been highly correlated with capital and gold outflows. Also changes in the British discount rate had a significant effect on French monetary policy in the expected positive direction.

The interpretation of the negative coefficient of Δi^A is more difficult. First of all this coefficient is significantly different from zero only after the turn of the century (see the recursive parameter estimates in Figure 1). In the 1880s and 1890s the Austro-Hungarian silver and/or paper currency was fluctuating and it was to some extent a "speculative currency". Flandreau (1999) reports that on September 21, 1899 the charter of the Austro-Hungarian Bank was finally passed into law and was renewed for another 10 years after long and exhausting negotiations between the two sides of the empire. This must have boosted the confidence in the monetary stability of the empire and attracted capital and gold on a relevant scale from the other three major financial centres. The strain in the reserves of the Central Banks of the three main centres to the benefit of Austria-Hungary is clearly visible in our data on their balance sheets. The strain led finally to the November/December round of discount rate increases. On November 30, 1899 the Bank of England increased the discount rate by a full percentage point and on December 7 the Banque de France increased it by half a percentage point while Austria-Hungary reduced it by the same amount. On December 19 Germany increased the discount rate by a full percentage point, followed on December 21 by France with an increase of equal magnitude. The December 7, 1899 episode of changes in opposite directions in the official discount rates of France and Austria-Hungary is the only episode of same-day changes in opposite directions recorded during the period. It may be relevant to understand the negative and significant sign of Δi^A in equation (1). Even though same-day changes in discount rates are not included by construction in the data used, this episode may be representative of the kind of disturbances which must have occurred from time to time between Vienna and the other three more stable centres.

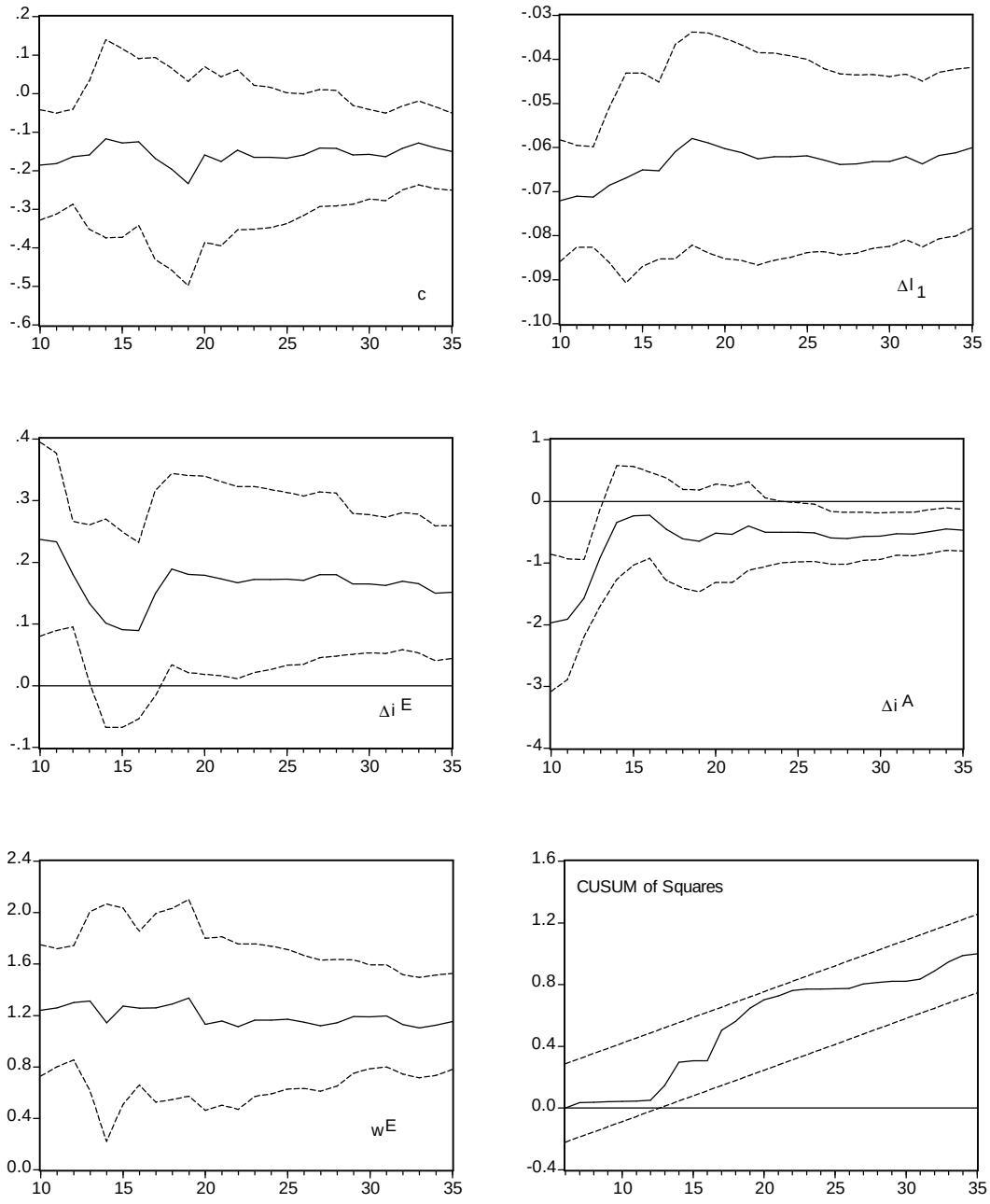
Table 2: The determinants of the official discount rate for the period 1876 – 1913 (T = 35)

	(1) Δi^F	(2) Δi^F	(3) Δi^F	(4) Δi^F
C	-0.150	-0.121	-0.141	-0.100
	(3.0)	(2.3)	(2.4)	(1.6)
Δl_1	-0.060	-0.072		
	(6.6)	(10.4)		
Δl_2			-0.088	-0.100
			(5.1)	(8.8)
Δi^E	0.152		0.138	
	(2.8)		(2.1)	
Δi^A	-0.469		-0.537	
	(2.8)		(2.8)	
w^E	1.153	0.988	1.215	0.999
	(6.2)	(5.3)	(5.7)	(4.7)
$\bar{R}^2$	0.886	0.859	0.850	0.821
DW	1.80	1.58	1.65	1.34
AIC	0.106	0.267	0.381	0.505
SC	0.328	0.400	0.603	0.639
Q(10)	7.64	18.11	5.69	13.74
	[0.66]	[0.05]	[0.84]	[0.19]
HET	0.68	1.16	0.73	1.00
	[0.70]	[0.20]	[0.66]	[0.42]
JB	1.34	2.24	1.74	1.68
	[0.51]	[0.33]	[0.42]	[0.43]
RESET	12.19	3.84	9.46	2.97
	[0.00]	[0.06]	[0.01]	[0.10]

Notes:
Absolute values of the t-statistics are given in parantheses, p-values in brackets. DW denotes the Durbin-Watson statistic. Q(10) denotes the Box-Pierce Portmanteau statistic with 10 lags to test for white noise in the residuals. HET is the White test for heteroskedasticity in the residuals. The RESET test tests against specification errors. The Akaike (Schwarz) information criterium is denoted as AIC (SC).

Apart from Vienna, the only other Central Bank which significantly influenced the French discount rate in the expected direction was the Bank of England. However, once we remove the changes in the discount rate in Vienna the coefficient of the British one becomes insignificantly different from zero. This has to do with the fact that the interest rate in Vienna and London tended to move at times in opposite directions as explained above.

Figure 1: Recursive estimates and CUSUM of Squares test for regression (1) of Table 2



The regressions explain from 82 to 88% of the variability of changes in the French official discount rate, depending on the liquidity ratio used and the specification of the equation. The narrowly defined liquidity ratio seems to have been slightly more important for the Banque de France as it explains a higher fraction of the variance. The residuals of the regressions of Table 2 are not autocorrelated, not heteroskedastic and do not show deviations from normality. However, the F-Reset test shows possible nonlinearities. The Cusum of Squares test of regression (1) in Table 2 is shown in Figure 1. It indicates that at the 5% significance level the relationship is stable and that no structural break occurred during the

period. The recursive parameter estimates of the coefficients of this regression are also shown in Figure 1. They do not show statistically significant changes in the coefficients over time, except for Δi^E. One observes a dip in the coefficient of Δi^E from about the 12^{th} to the 18^{th} observation. In addition, during this interval, the coefficient of Δi^E is not significantly different form zero. This may be caused by the heavier use of gold devices on the part of the Bank of France and the Bank of England during this period. The 12^{th} observation corresponds to March 23, 1882 and the 18^{th} to January 24, 1889. A short historical account of the use of gold devices by the Bank of France and the Bank of England during this period is therefore necessary. Gold devices were used by Central Banks to avoid sales and exports of gold and/or to make these operations more costly to the private sector. They consisted in raising the sales price of gold, moving the delivery of gold to places distant from the border, delivering minted national coins instead of ingots, and increasing the interest rates on lending to gold exporters in order to increase transaction costs. The Banque de France did at times even refuse to deliver gold outright (M. le Baron de Rotschild, see the citation below).

The Bank of France did not change the discount rate from February 22, 1883 to February 16, 1888, the longest period on record since 1876. The fact that they managed to keep the discount rate stable at 3% for 5 years, while the Bank of England changed it 35 times during this period gives ground to the suspicion that especially the Bank of France was using other instruments of monetary policy. From the September 13, 1888 minutes of the meeting of the Conseil Général, when the discount rate was raised by a full percentage point from 2.5 to 3.5%, we know that there was a major clash between M. le B.^{on} de Rotschild and two other members of the Council, M. Desmarest and M. Mallet on the excessive use of gold devices on the part of the Banque de France up to that date. The debate was so lively and revealing that it is worth reporting here a few sentences from the intervention of M. le B.^{on} de Rotschild:

"...la Banque ne doit pas se borner à défendre son encaisse (*metal stock*, italic our addition) en refusant de donner de l'or à ceux qui lui en demandent; elle doit aussi défendre la circulation du pays et pour cela elle n'a qu'un moyen, c'est de surveiller soigneusement le cours des changes et d'élever le taux de son escompte quand les changes dépassent sensiblement leur niveau normal."

"M. le B.^{on} de Rotschild demande instamment ou Gouverneur de la Banque de se montrer moins restrictif quant'à l'or qui lui est demandé, et d'en donner plus liberalment que dans le passé."

"Les mésures que le Conseil Général vient de voter rélativement à l'élévation de l'escompte a pour object de faire fléchir le cours des changes (*appreciate the franc*), or cet effet sera contrecarré et amoindri si la Banque

continuait à refuser l'or, et par la rarefation de ce métal, poussait indirectement à l'élévation du change (*depreciation of the franc*)."

M. le C.te Pillet-Will, another member of the Council, was supporting M. de Rotschild's attack on the excessive use of gold devices. We read in the minutes:

" ..(M. le C.te Pillet-Will) ... regrette que la Banque ait renoncé à ses habitudes d'autre fois et ne donne plus de l'or a tous ceux qui en ont besoin."

It is clear from the above citations that the use of gold devices on a scale above normal had been going on for some time and that they were seen by M. le Baron de Rotschild as very imperfect substitutes of changes in the discount rate as instrument of monetary policy. In the third statement reported above he maintains that the defence of the gold stock by means of an increase in the discount rate leads to an appreciation of the exchange rate, while the defence by means of gold devices leads to depreciation. In addition it is clear that the extensive use of gold devices had become unbearable to more than one member of the Board. We did find evidence of a heavier use of gold devices also on the part of the Bank of England from about 1885 to 1892/93 (Tullio and Wolters, 2003) and Scammel (1965) and Sayers (1976) do confirm this heavier use.

If our interpretation of the dip in the absolute value of the coefficients of Δi^E in the estimates of equation (1) in Table 2 is correct, it was the Banque de France which initiated the move towards stricter capital controls in the 1880s, preceding the Bank of England by about three years. In this sense the Bank of England's move may have been retaliation.

The coefficient of changes in the liquidity ratio shows a slight upward drift suggesting a non significant reduction in its role over time (see Figure 1). The Cusum of Squares test and the recursive parameter estimates of regressions using the second liquidity ratio show a very similar behaviour to the one observed in Figure 1 and they are therefore not shown here to save space[15].

So far we performed only a very rudimentary test of asymmetric reaction on the part of the Banque de France by introducing into equation (1) the level of the liquidity ratios. No evidence of asymmetric behaviour was found. A more formal test consists in splitting the observations of each explanatory variable into two groups: the observations referring to episodes of increases in the discount rate and those referring to decreases. For this purpose we defined the dummy variables DP and DN. DP is equal to one if Δi^F is positive and zero

otherwise and DN is equal to 1-DP. Then we multiplied each explanatory variable with DP and with DN and ran the regressions of Table 2 again with all new variables thus formed. The results for regressions (2) and (4) of Table 2 are shown in Table 3.

Table 3: Determinants of the official discount rate: Tests of asymmetry
Period 1876 – 1913 (T = 35)

	(1) Δi^F	(2) Δi^F	(3) Δi^F	(4) Δi^F
C	-0.273	-0.156	-0.213	-0.148
	(3.7)	(3.4)	(2.4)	(3.1)
$DP\Delta l_1$	-0.084			
	(7.3)			
$DN\Delta l_1$	-0.047			
	(4.1)			
Δl_1		-0.065		
		(10.6)		
$DP\Delta l_2$			-0.105	
			(5.9)	
$DN\Delta l_2$			-0.076	
			(4.1)	
Δl_2				-0.090
				(10.1)
$DP\, w^E$	1.389	1.363	1.495	1.460
	(7.6)	(7.3)	(7.5)	(7.6)
$DN\, w^E$	0.216		0.009	
	(0.8)		(0.0)	
$\bar{R}^2$	0.906	0.900	0.889	0.893
DW	1.92	1.86	1.65	1.68
AIC	-0.091	-0.078	0.080	-0.006
SC	0.131	0.055	0.302	0.128
WALD (Δl_i)	3.57		0.84	
	(0.07)		(0.37)	
WALD (w^E)	14.17		20.04	
	(0.00)		(0.00)	
Q(10)	11.62	10.42	6.06	5.09
	(0.31)	(0.40)	(0.81)	(0.89)
HET	1.70	2.19	1.49	1.81
	(0.15)	(0.09)	(0.21)	(0.15)
JB	0.45	0.57	0.12	0.72
	(0.80)	(0.75)	(0.94)	(0.70)
RESET	16.33	0.38	14.35	0.11
	(0.00)	(0.54)	(0.00)	(0.74)

Notes: see Table 2

[15]They are available from the authors upon request.

A Wald F-test indicates that at the 5% level of significance we cannot reject the hypothesis of symmetric behaviour on the part of the Banque de France with respect to changes in the narrow liquidity ratios. With respect to deviations of the Pound from parity we do instead find strong evidence of asymmetry: the Banque de France reacted very strongly to depreciations of the Franc by increasing the discount rate more than in proportion to the depreciation (the coefficient of DPw^{E} is larger than 1). Vice versa in times of ease, the appreciations of the exchange rate from parity had no significant effect. This finding has important implications for the gold accumulation policy of the Bank: when capital and gold outflows were leading to falling liquidity ratios and to a weakening Franc, the reaction of the Bank was prompt and large. Capital and gold inflows and an appreciating currency did not bring forth any change in the discount rate.

We reported in the introduction how the distribution of gold between the Bank of England, the Reichsbank and the Banque de France changed significantly in favour of France at the expense of Great Britain during the gold standard. This and the evidence of asymmetric behaviour found here, suggest that France contributed to undermine the stability of the gold standard in the long run by making the management of the system on the part of the Bank of England more difficult. This evidence also reminds us that the gold accumulation policy of France observed in later periods was nothing new (1928/29 and under General De Gaulle in the 1960s).

When these asymmetries are taken into account and non significant variables are eliminated from the regressions the functional form misspecification disappears (see the F-Reset tests) and the goodness of fit according to the AIC and SC measures improves considerably (cf. equations (2) and (4) of Tables 2 and 3).

5 Conclusions

This paper presents an equation explaining changes in the discount rate of the Banque de France during the classical gold standard. The data used is “not equally spaced chronologically ordered” and relate to each discount rate change enacted by the Banque de France from 1876 to 1913. The explanatory power of the estimated regressions always exceeds 80%, which is very high considering that the dependent variables are changes. The residuals of the final regressions also pass all the standard tests.

The estimates presented in this paper suggest the following main conclusions. *First*, changes in the liquidity ratios were the main determinants of changes of the French official discount rate, confirming that maintaining convertibility of banknotes issued into gold and

defending the gold stock were the main objectives of the Banque de France. *Second*, the Bank of England was exerting an important influence on the Banque de France's decisions to change the discount rate. Both changes in the London discount rate and fluctuations of the Pound were found to be significant. Also the discount rate in Vienna exerted a significant and negative effect on the discount rate of the Banque de France. This is because at times Vienna was subject to heavy capital inflows or outflows of a speculative nature.

Third, the recursive parameter estimates and the strong statements made by M. le B.^{on} de Rotschild at the September 13, 1888 meeting of the Conseil Général suggest that the Bank of France may have used gold devices more intensively from about 1882 to 1889. The recursive parameter estimates show that during this period the influence of London and Vienna's discount rates on the French one was significantly lower. Also in the parallel study on the Bank of England we found that from about 1885 to 1893 the influence of the Reichsbank on the Bank of England was significantly smaller than either before or after (see Tullio and Wolters, 2003).

Fourth, we found evidence of asymmetric behaviour on the part of the Banque de France with respect to deviations of the French Franc-Pound exchange rate from gold parity, suggesting that capital and gold outflows were leading to a significantly stronger reaction than equivalent capital and gold inflows. This finding coupled with the gold accumulation policy of France suggests that the role of Paris in undermining the long run stability of the gold standard system must have been large.

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