Diskussionsbeiträge
des Fachbereichs Wirtschaftswissenschaft
der Freien Universität Berlin

Nr. 2004/23

VOLKSWIRTSCHAFTLICHE REIHE

Domestic and International Determinants of the Bank of France's Liquidity Ratios during the Classical Gold Standard, 1876-1913: an econometric analysis

Giuseppe Tullio and Jürgen Wolters

ISBN 3-935058-92-6

Domestic and International Determinants of the Bank of France's Liquidity Ratios during the Classical Gold Standard, 1876-1913: an econometric analysis[1]

by
Giuseppe Tullio and Jürgen Wolters
(Luiss University Rome and Freie Universität Berlin)

The first author is associated to Luiss University, Rome (Via Tolmino 12, 00198 Roma, Italy, e-mail: gt@giuseppetullio.com) and the second at the Freie Universität Berlin (Boltzmannstrasse 20, 14195 Berlin, Germany, e-mail: wolters@wiwiss.fu-berlin.de).

Introduction

This paper analyses for the period January 1, 1876 to the end of 1913 the factors which influenced the Bank of France's liquidity ratio, defined as the ratio of gold and silver holdings to banknotes outstanding. A key aspect of the gold standard, as this period came to be called, was the legal obligation on the part of Central Banks to convert on request banknotes into gold. France was a bit of an exception among gold standard countries in the sense that the Bank of France was not under a strict legal obligation to deliver gold, although in normal times it did comply. The Banque of France is known to have frequently refused the delivery of gold, especially from 1882 to 1889, to have had the tendency to deliver preferably silver and to have used frequently moral suasion to influence the behaviour of banks, gold dealers and of large customers. In any case the Banque of France was submitted to a legal obligation to deliver silver and a moral one to deliver gold. From this obligation resulted the "discipline" imposed by the stock of metals on governments and Central Banks at the times. The minimum metal cover of notes outstanding was established by law and varied from country to country. As Central Banks could not let the metal cover of notes issued fall below the legally established minimum, it is clear that the liquidity ratio was constantly monitored, leading to apprehension when it was falling rapidly and or approaching the legal minimum and to a relaxed attitude when it was increasing.

[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: 1876-1913" and written under the supervision of the first author. We thank Hannah Nielsen for research assistance and Paul Gregory for helpful comments.

The Central Banks had a very powerful instrument at their disposal to stop the ratio from falling and invert its decline. This instrument was the discount rate, which was the interest rate they applied on their lending to commercial banks and to the public[2]. An increase in the discount rate attracted in the first place capital flows and gold from abroad, thus contributing to increase the Central Bank's gold stock. It also reduced the demand for rediscounting at the Bank and the level of economic activity in the country, thus reducing the stock of banknotes outstanding. Hence both the numerator and the denominator of the ratio would move in the right direction. The analysis of the determinants of the liquidity ratio is therefore crucial to understand the objectives of monetary policy during the classical gold standard to the extent that its changes caused changes in the discount rate and changes in the discount rate were the main instrument to control the liquidity ratio.

Changes in the discount rate were the most important instrument of monetary policy during the classical gold standard. A second instrument was changes in the criteria for admission to rediscounting by commercial banks and of borrowing by the non-banking private sector which at that time had also access to Central Bank credit. The third instrument was the use of so-called gold devices[3] which changed the conditions of gold shipments abroad and hence the width of the band around the gold parity within which the market exchange rate fluctuated.

In a study on the Reichsbank Sommariva and Tullio (1987) show that the differential between the average discount rate of major commercial banks in Berlin and the Reichsbank's discount rate, a measure of the "tension" on the Bank's gold stock, is a very significant determinant of the liquidity ratio. They show that the effect is negative and offer explanations of why this should be so. In this paper on France we also focus on the differential between the average discount rate of major commercial banks in Paris and the Banque de France's discount rate (henceforth called "the differential") as the main determinant of the liquidity ratio.

In addition, we include among the explanatory variables of the liquidity ratio also foreign official discount rates and the deviations of the French Franc from the gold parity recorded in London. The inclusion of foreign variables allows us to study the extent to which the Paris financial market and the Bank of France's liquidity ratio were influenced by financial

[2]At that time the Bank of France was was also operating as a commercial bank, as all other gold standard Central Banks.

[3] 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 increase the interest rates on lending to gold exporters in order to increase transaction costs.

conditions abroad, which were the most important gold standard countries influencing Paris, the degree of international financial market integration at that time and whether it changed significantly from 1876 to 1913. They also allow us to test if there were periods during which the use of gold devices by the Bank of France and/or other gold standard Central Banks significantly changed the coefficients of the estimated relationships.

Like Sommariva and Tullio (1987) we use the data contained in a rather rare volume published in 1925 in Berlin by the German Imperial Printing Office and entitled "Vergleichende Notenbankstatistik" (1925) (henceforth: VN). They cover four gold standard countries (Germany, Great Britain, France and Austria-Hungary) using the same criteria for all four countries and contain, besides discount rates and liquidity ratios, also data on exchange rates and private (commercial bank's) discount rates. Other advantages of these data are that they are available for the whole period from January 1, 1876 to 1913 and that because of their identical construction for four gold standard countries they also allow meaningful international comparisons. In this paper we also present stability tests of the estimated regressions to gain insights into whether the working of the gold standard changed significantly during this 38 year period.

The paper is structured as follows: Section 1 presents the model explaining the Bank of France's liquidity ratio taking into account international influences. Section 2 describes in detail the data used and how the variables have been constructed. Section 3 presents the estimates of the model and Section 4 concludes.

1. The model

In this section we present an equation explaining the changes in the Bank of France's liquidity ratio. Following Sommariva and Tullio (1987) it is assumed that changes in the liquidity ratio depend on the differential between the private and the official discount rate in France. However, in order to test how the degree of international financial market integration changed through time and which foreign Central Banks most influenced the Banque de France, a set of variables capturing international influences (market exchange rates and foreign official discount rates) was included among the explanatory variables.

Thus the equation to be estimated is:

$$(1) \qquad \Delta l_i = a_1 + a_2(i_P - i^F) + \sum_j a_{3,j}\Delta i^j + \sum_j a_{4,j} w^j + u$$

where Δl_i denotes a change in the liquidity ratios of the Bank of France. We shall use a narrow (i=1) and a broad definition (i=2). The first is the ratio of the gold and silver stock to banknotes issued by the Bank of France (l_1) , and the second has the same numerator but includes in the denominator sight liabilities in addition to banknotes issued (l_2). 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.

$i_P - i^F$ denotes the differential between the private discount rate in Paris and the Bank of France's discount rate. The superscript F stands for France; Δi^j denotes changes in the discount rate of country j, where the superscript $j = E$ stands for Great Britain, D stands for Germany and A for Austria-Hungary; $w^j = (e_j - e_j^*)/e_j^*$ denotes percentage deviations of the market exchange rate of the French Franc with the currency of country j with respect to the gold parity; the asterisk indicates the gold parity and the variable "e_j" the market exchange rate. Note that the gold parity never changed during the whole period for Great Britain, Germany and France.

Equation (1) states that the main domestic determinant of changes in the liquidity ratio is the differential which reflects the situation of the domestic business cycle and the liquidity position of the Paris financial market. The differential must have had a very high informative content for the markets and the monetary authorities[4]. An increase in the differential put the Bank of France under strain as it led to an increased demand for rediscounting on the part of commercial banks and an increased demand for banknotes, metals and Bank of France credit by the private sector and hence led to a fall in the liquidity ratio.

The channels between the business cycle and the liquidity ratio or its components have been studied by Goodhart (1972) for Great Britain, McGouldrick (1984) and Sommariva and Tullio (1987) for Germany and more recently by Contamin and Denise (1999) for France. Unfortunately we cannot introduce the business cycle into this model because we have no data on industrial production and/or GDP comparable to those of VN.

In addition to the differential, the liquidity ratio is assumed to depend on foreign discount rates and the deviation of market exchange rates from the gold parity. The expected signs of the coefficients of the explanatory variables are: negative for the differential, negative for changes in foreign official discount rates and negative for the deviation of the exchange rate from the gold parity. The exchange rate is defined as the number of French Francs per

[4]At that time data on GDP and industrial production were not available.

foreign currency unit (British Pound); hence an increase in e_j indicates a depreciation of the French Franc (capital and gold outflows from France).

For the exact definition of the variables and for the time span to which they 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. From 1876 to 1913 the Bank of France changed the official discount rate 35 times.

Changes in foreign discount rates are measured over a period similar to the one chosen by the compilers of the tables of VN to measure changes in liquidity ratios. The exact definition of the intervals over which the changes in the foreign discount rates are measured is also discussed in Section 2.

2. Description of the data used

The VN data used in this paper are obtained from a 1925 volume entitled Vergleichende Notenbankstatistik: Organisation und Geschäftsverkehr Europäischer Notenbanken, 1876 – 1913. This two-volume publication contains monthly and annual financial data for seven European countries: Austria-Hungary, Belgium, France, Germany, Holland, Great Britain and Russia. For four countries: France, Germany, Great Britain 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). In order to facilitate the description of the data we partially reproduce below in Table 1 the columns of Table 134 of VN and the data actually used in the empirical work.

The one and a half page long introduction to this set of tables in VN contains 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 follows 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 column in Table 1 contains the month, day and year of the official discount rate change. The second column contains the date of the closest statement of the Bank of

France used by the compilers of the table, and possibly also by the members of the Board at the meeting during which the discount rate change was decided[5], to analyse the factors leading to the decision to change the discount rate. The date of the closest statement coincides with the day of the discount rate change in 33 out of 35 cases.[6] The third column contains the date of the more distant statement used for comparison. The interval between the two statements was chosen by the compilers of the table. In choosing these reference intervals the compilers were interested in eliminating disturbances to the balance sheet items of the Bank caused by seasonal factors or special events. For the whole period the average interval between the two statements was 57.4 days. The interval increased from 54 days in the period 1876-1895 to 62.7 days in the period 1896-1913. The increase observed from the first to the second period in the reference interval may be an indication that the Bank of France was operating the domestic gold standard with a more

abundant gold stock and that it felt more relaxed about its main duty, which was to maintain internal convertibility of banknotes.

Columns 4 and 5 contain the changes in the narrow and broad definition of the liquidity ratio between the two dates reported in columns 2 and 3. l_1 is defined as the ratio between the gold and silver stock of the Bank of France and its banknotes outstanding. l_2 is defined as the ratio of the gold and silver stock of the Bank to the sum of banknotes issued plus sight deposits.

Column 6 contains the differential between the average private discount rate of major commercial banks in Paris and the official discount rate of the Bank of France on the day prior to the discount rate change. It is worth mentioning that in VN this differential is called "the tension" (*Spannung* in German).

Column 7 reports the exchange rate, defined as the number of French Francs per Pound in London, on the day before the discount rate change. In order to obtain the percentage deviations of the market exchange rates from gold parity, we used the gold parity reported in Gallarotti (1995), where one Pound is equivalent to 25.225 French Francs.

[5]This is our supposition.

[6] On one occasion it preceeds the day of the discount rate change by one day (May 26, 1876) and on one occasion it follows it by one day (October 16, 1878), where the dates indicated in parenthesis refer to the day of the discount rate change.

Table 1: Discount rate changes of the Bank of France, 1876 – 1913. Some representative data at the beginning and at the end of the period.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Date of discount rate change	Date of closest statement used	Date of statement used for comparison	Δl_1	Δl_2	$i_P - i^F$	e^E	Δi^D	Δi^E	Δi^A
1	May 26, 1876	May 25, 1876	Jan. 6, 1876	15,2	67,3	-2,00	25,23	-2,5	-3,0	-0,5
2	Apr. 5, 1877	Apr. 5, 1877	Jan. 4, 1877	5,8	72,5	-1,25	25,16	-0,5	0,0	0,0
3	Oct. 16, 1878	Oct. 17, 1878	Aug. 29, 1878	-5,3	-3,1	0,75	25,325	0,0	1,0	0,0
4	May 23, 1879	May 23, 1879	Jan. 2, 1879	13,3	9,0	-1,25	25,195	-1,5	-3,0	-0,5
5	Oct. 23, 1879	Oct. 23, 1879	Aug. 21, 1879	-10,4	-6,8	0,375	25,28	0,5	0,0	0,0
6	Apr. 1, 1880	Apr. 1, 1880	Jan. 2, 1880	8,8	7,3	-0,875	25,27	0,0	0,0	0,0
7	Oct. 14, 1880	Oct. 14, 1880	Aug. 26, 1880	-10,9	-4,6	0,5	25,335	0,0	0,0	0,0
⋮										
33	May 17, 1912	May 17, 1912	Jan. 4, 1912	8,3	6,6	-0,375	25,225	0,0	-1,0	0,0
34	Oct. 17, 1912	Oct. 17, 1912	Aug. 22, 1912	-8,1	-5,3	0,25	25,245	0,0	2,0	0,0
35	Oct. 31, 1912	Oct. 31, 1912	Aug. 22, 1912	-11,0	-8,5	0,0	25,235	0,5	2,0	0,5

Source: Table 134 of VN

Changes in the official discount rates in Germany (Δi^D), Great Britain (Δi^E) and Austria-Hungary (Δi^A) (see columns 8 to 10) are not reported in Table 134 of VN. For their construction, we had to use information contained in the 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 in column 3 and the day before the discount rate change.

To summarize four observations are in order. *First*, the data presented in Table 1 can be divided into four main categories:

A. For each discount rate change information on the balance sheet items of the Bank of France, in other words on its assets and liabilities, on two reference days as described above.

B. The differential between the private discount rate of major commercial banks in Paris and the official discount rate of the Bank of France on the day prior to the discount rate change.

C. The market exchange rate of the French Franc with the Pound on the day preceding the change in the discount rate.

D. The changes in foreign official discount rates.

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 were constructed. How they 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[7].

By estimating equation (1) with the data presented in this section we make use of an incredible wealth of information which has never been used before.

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

3. Domestic and foreign determinants of the Banque de France's liquidity ratios

In this section we present ordinary least squares estimates of equation (1) which explains changes in the liquidity ratios Δl_i, $i = 1,2$, of the Bank of France for the period from 1876 to 1913. The hypothesis underlying the equation is that foreign discount rates (Δi^E, Δi^D, Δi^A), the exchange rate of the Franc with the Pound[8] and the differential $i_P - i^F$ played a significant role in determining fluctuations of the liquidity ratios. We started out with all explanatory variables in the regression and then eliminated successively all non significant ones.

The estimates are presented in Table 2. The exchange rate of the Pound is never significant. The differential has a significant negative effect on the liquidity ratios as expected. A 100 basis points higher differential on the day prior to the official discount rate change implies a fall of 4.6 to 6.4 percentage points in the first liquidity ratio and 1.9 to 2.4 in the second. France differs significantly from Great Britain and Germany insofar as the effect of the differential on liquidity ratios is roughly half. (Tullio and Wolters 2004a and 2004b). This difference in behaviour between France and the other countries may imply that the Banque de France was stabilizing to some extent its liquidity ratios by using credit and foreign exchange controls and limiting access to its metal stock, especially its gold stock. Tullio and Wolters (2003) present evidence that this was particularly the case between 1882 and 1889. They base this evidence on estimates of the Bank's reaction function and on excerpts from the minutes of the September 13, 1888 meeting of the Conseil Général de la Banque de France. In addition, one should not forget that the Banque de France was not legally obliged to convert notes into gold as it could offer instead silver for conversion[9]. Finally Flandreau (1995) and Contamin and Denise (1999) show that the Bank was systematically selling gold at a premium thus regulating the foreign exchanges with this tool. It stopped using the premium only in the first decade of the 20th century when it started performing open market operations in the London financial market to stabilize British interest rates in order to protect the Bank of France's gold stock.

[8]Data on the exchange rates of the Franc with the Reichsmark and the Austro-Hungarian currency are not available from our source for the whole period.

[9]The Bank of France's silver holdings were very large compared to the other Central Banks considered in this paper.

Table 2: The determinants of the French liquidity ratios
Period 1876 – 1913 (T = 35)

	(1) Δl_1	(2) Δl_1	(3) Δl_1	(4) Δl_1	(5) Δl_2	(6) Δl_2	(7) Δl_2
c	-1.798	-1.830	-1.698	-1.925	-0.493	-0.509	-0.414
	(2.5)	(2.4)	(2.8)	(3.1)	(1.0)	(0.9)	(1.0)
$i_p - i^F$	-4.612	-4.897	-5.358	-6.409	-1.860	-2.096	-2.446
	(4.9)	(5.0)	(6.1)	(9.0)	(2.8)	(2.9)	(4.0)
Δi^D		-3.497				-3.444	
		(4.1)				(5.5)	
Δi^E	-2.207				-2.133		
	(4.7)				(6.4)		
$D1\Delta i^D$			-2.027				-2.313
			(1.9)				(3.3)
$D2\Delta i^E$			-2.922	-2.846			-2.611
			(6.3)	(5.9)			(8.2)
$\bar{R}^2$	0.746	0.718	0.811	0.795	0.735	0.693	0.815
DW	2.52	2.12	2.49	2.37	2.59	2.23	2.73
AIC	5.463	5.567	5.191	5.248	4.943	4.943	4.452
SC	5.597	5.700	5.369	5.381	4.787	4.934	4.630
Q(10)	7.26	7.99	8.93	6.38	6.47	5.33	8.26
	[0.70]	[0.63]	[0.54]	[0.78]	[0.77]	[0.87]	[0.60]
HET	1.11	0.49	0.53	1.12	1.06	0.41	0.37
	[0.37]	[0.74]	[0.78]	[0.32]	[0.39]	[0.80]	[0.89]
JB	0.66	0.24	0.29	0.05	0.51	0.43	1.08
	[0.72]	[0.89]	[0.86]	[0.97]	[0.77]	[0.81]	[0.58]
RESET	0.19	0.09	0.01	0.26	0.38	0.17	0.00
	[0.67]	[0.77]	[0.92]	[0.61]	[0.54]	[0.69]	[0.99]

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).

Our data show that the variance of Δl_1 and Δl_2 for France was 1/6 to 1/3 of the variance in Great Britain and Germany. This remarkable stability of the liquidity ratios of the Bank of France is difficult to explain without a more intensive use of credit controls and gold devices, a larger degree of discretion on the part of the Bank, and the heavier exercise of moral suasion on the banking system and on other customers. Thus the results presented suggest that France's relatively limited number of official discount rate changes was not only due to its higher metal stock but also to the "stabilization" of liquidity ratios by means of direct controls.

When changes in the British and German discount rates are introduced together, neither has a coefficient which is significantly different from zero. However, when introduced separately they are both significantly different from zero and have the expected negative sign (cf. regressions (1) and (2) or (5) and (6) of Table 2). A 100 basis points increase in the official discount rate in Germany led to a decrease of about 3.5 percentage points in both liquidity ratios (see regressions (2) and (6) of Table 2). The effect of changes in the Bank of England's discount rate is smaller than Germany's; however, it is more significant and the regressions with the British discount rate (and without the German one) explain a higher fraction of the variance of the dependent variable[10] (cf. regressions (1) and (2) or regressions (5) and (6) of Table 2). These two factors would suggest that for Paris London was more important than Berlin, at least for the average of the sample period[11].

A closer investigation reveals that Δi^D had a significant effect on $\Delta l_i, i = 1,2,$ only in the period from 1876 to 1895 and that Δi^E had a significant effect only in the period from 1896 to 1913.[12] Owing to the insufficient number of observations, we could not estimate equation (1) separately for these two sub-periods. Therefore, we defined a dummy variable D1 which is equal to one for observations 1 to 21 (1876 to 1895) and zero otherwise and a dummy variable D2 which is equal to 1-D1 (1 from 1896 to 1913 and zero otherwise). We then multiplied D1 with Δi^D and D2 with Δi^E and ran the regressions again with these new explanatory variables.

The chosen subdivision of the period is justified by several historical facts. Among them should be mentioned the end of the long period of declining prices in the gold standard world in connection with the discovery of new gold mines and of a new process to extract gold and the end in the late 1880s and early 1890s of a period characterized by a more intensive use of gold devices on the part of the Banque de France and the Bank of England. Other important developments to justify the split were the improved communication and transportation technology, the increased degree of integration of financial markets worldwide, the increased economic and financial weight of Germany in the world economy and the development of the Pound as an international reserve currency.

The regressions with the newly defined explanatory variables are also contained in Table 2 (see regressions (3), (4) and (7)). The finding that Berlin influenced Paris only in the

[10]See also the AIC and SC statistics.

[11]This conclusion that London was more important for Paris is in line with the findings of Tullio and Wolters (2003).

first period and London only in the second has two possible non-conflicting explanations. *First* it may be explained by the large disturbance caused by Germany in the first sub-period to the world gold market, and especially in its early years, when it was trying to first establish and then consolidate its new monetary system by purchasing large amounts of gold at a time when production was rather low. This "German effect" was magnified by the fact that several minor European countries which did not want to see their currency depreciate were forced to also adopt the gold standard. Hawtrey (1927) characterized this uncoordinated and abrupt move by Germany as the greatest disturbance to hit the international monetary system in the second half of the 19th century and considered it as the main cause of the long phase of declining world prices which lasted from 1873 to 1895.

Second Tullio and Wolters (2004a) find strong evidence of a more intensive use of gold devices on the part of the Bank of England from about 1885 to 1892/3. During this period the influence of the German discount rate on the British liquidity ratios become insignificant. This more intensive use of gold devices on the part of the Bank of England, coupled with a more intensive use by the Banque de France from about 1882 to 1889, may have severed the Paris financial market from the London one for a good part of the period 1876-1895. Both these factors, a large monetary shock originating in Germany and a more intensive use of gold devices by France and Great Britain, could have contributed in the first period to reduce the coefficient of changes in the Bank of England's discount rate to insignificance while at the same time enhancing the German influence on Paris.

The Adjusted R2's of the regressions of Table 2 range from 0.69 to 0.82. They are extremely high considering that the dependent variable is defined as a change. The residuals of the regressions of Table 2 are well behaved: they pass the standard tests of absence of auto-correlation and heteroskedasticity and the normality hypothesis cannot be rejected. They also pass the Functional Form Misspecification F-RESET test. Figure 1 presents the Cusum of Squares test and the recursive parameter estimates of the regression explaining Δl_1 as a function of Δi^E and the differential in Paris (regression (1) of Table 2). Figure 2 presents the corresponding tests for the regression explaining Δl_2 (regression (5) of Table 2). Figures 1 and 2 show that the regressions are stable as the statistic of the Cusum of Squares test does not move outside the 5% confidence interval. By adding the German discount rate to the British one the regression becomes unstable, as shown by the Cusum of Squares test for regression (7) of Table 2 (see Figure 3). The substitution of the German discount rate to the British one

[12] See for instance the recursive parameter estimates in Figures 1 and 2. Recursive parameter estimates for regressions 2 and 6 of Table 2 are not presented to save space.

also makes the regression unstable, as shown by the Cusum of Squares test for regression (6) of Table 2 (see Figure 3).

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

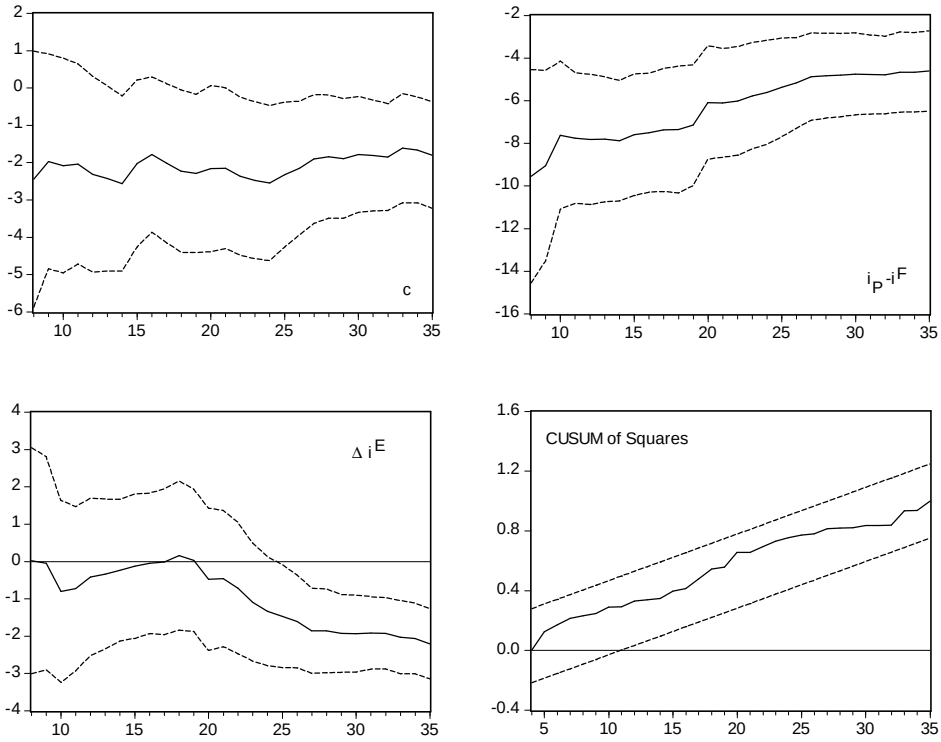


Figure 2: Recursive estimates and CUSUM of Squares test for regression (5) of Table 2

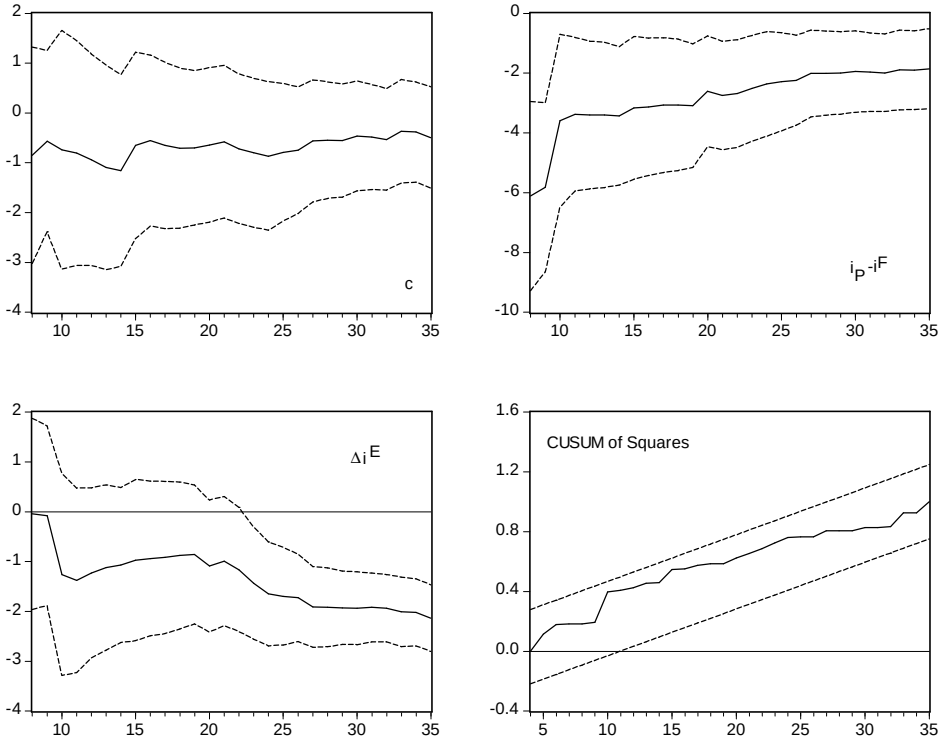
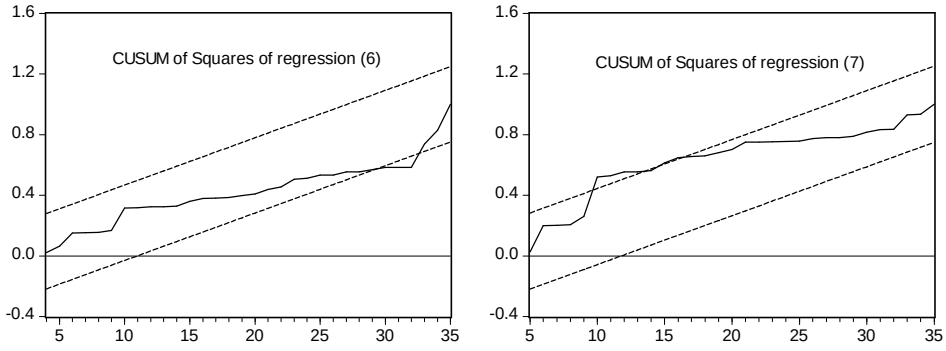


Figure 3: CUSUM of Squares tests



The recursive parameter estimates are also contained in Figures 1 and 2. For both stable regressions (regressions (1) and (5)) one observes a tendency of the coefficient of the differential to fall in absolute value while the coefficient of changes in the Bank of England's discount rate increases in absolute value. In particular one sees that the coefficient of Δi^E is not significantly different from zero in the first sub-period (1876-1895) and starts increasing sharply in absolute value after the 18th observation which corresponds to the January 24 1889 change in the Paris discount rate. The increased influence of London on Paris in the second period is likely to have something to do with the end of the more intensive use of gold devices on the part of both the Banque de France and the Bank of England, although it must have been superimposed on a longer run tendency of French financial markets to become more integrated with the rest of Europe, a long run tendency which also slowly reduced the importance of the domestic explanatory variable (the differential) in determining French liquidity ratios.

4. Summary of main results and conclusions

In this paper we have presented an equation explaining changes in the Bank of France's liquidity ratios during the classical gold standard (1876-1913). These are assumed to depend on the differential between the private and the official discount rate in Paris, on foreign discount rate changes and on deviations of the exchange rate of the French Franc with the Pound from the gold parity. Two liquidity ratios are used in this paper, a narrow and a broad one. In estimating the model it does not make much difference whether one uses the narrow or the broad definition.

We use data from Vergleichende Notenbankstatistik (1925) referring to all episodes of discount rate changes enacted by the Bank during the period. Since there were 35 such changes we have 35 observations. Thus the data used is "not equally spaced chronologically

ordered". We present stability tests in order to study the changes in the role of the determinants of the liquidity ratios and in the working of the gold standard over time.

The estimates presented in this paper suggest the following main conclusions. *First*, the differential played an important role in transmitting disturbances from the real sector and from the Paris financial market to the Bank of France's liquidity ratios. *Second*, foreign influences on French liquidity ratios cannot be neglected. Of the three foreign countries considered in this paper, Great Britain was the most important for French liquidity ratios, confirming the view held by contemporaries, followed closely by Germany. The regressions with changes in the London discount rate as explanatory variable had the highest explanatory power and were stable. Vienna's discount rate changes did not influence French liquidity ratios. The exchange rate of the Franc was not found to be a significant determinant of liquidity ratios. *Third*, the explanatory power of the estimated regressions is between 69 and 82%, which is very high considering that the dependent variable is a change. The residuals are well behaved.

Fourth, the recursive parameter estimates presented in this paper and the strong statements made by M. le B.^{on} de Rotschild at the September 13 meeting of the Conseil Général (Board Meeting) of the Bank of France (see Tullio and Wolters, 2003) suggest that the Bank may have used gold devices more intensively from about 1882 to 1889. *Fifth*, besides the more intensive use of gold devices from 1882 to 1889 on the part of the Bank of France, we also find some evidence of a systematic use of domestic credit controls and moral suasion.

Sixth, we decided to split the period from 1876 to 1913 into two sub-periods, using 1895 as the dividing line. The justifications for choosing this date are mentioned in Section 3. By splitting the period we find that in the first sub-period (1876-1895) the Reichsbank's discount rate had significant effects on French liquidity ratios while the Bank of England's did not. This is especially true for the broad liquidity ratio. In the second period (1896-1913) instead the London discount rate became significant while Berlin's discount rate became insignificant.

Seventh, we found evidence that after 1895 the degree of financial market integration in Europe was substantially higher. This greater integration was due in part to the fact that in the second period the Bank of France and the Bank of England used gold devices less intensively or abandoned them altogether and in part to the development in communication technology. In parallel with the increased influence of London on Paris in determining the French liquidity ratios, we find that the role of the Paris differential is reduced.

Eighth, turning to the validity of the multi-polar, bi-polar or "conductor of the orchestra" views of the international gold standard, our results strongly support a bi-polar or multi-polar view rather than "the conductor of the orchestra view" allegedly held by Keynes (1930).

We saw in this paper how Germany closely competed with Great Britain in determining changes in the French liquidity ratios to the point of "excluding" Great Britain in the first sub-period. This is in line with earlier findings of Eichengreen (1992) and Tullio and Wolters (1996, 2000).

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