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ABSTRACT

Under the classical gold standard (1880-1914), the Bank of France maintained a stable discount rate while the Bank of England changed its rate very frequently. Why did the policies of these central banks, the two pillars of the gold standard, differ so much? How did the Bank of France manage to keep a stable rate and continuously violate the "rules of the game"? This paper tackles these questions and shows that the domestic asset portfolio of the Bank of France played a crucial role in smoothing international shocks and in maintaining the stability of the discount rate. This policy provides a striking example of a central bank that uses its balance sheet to block the interest rate channel and protect the domestic economy from international constraints (Mundell's trilemma).

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The Price of Stability.

The balance sheet policy of the Banque de France and the Gold Standard (1880-1914)

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The textbook account of the classical gold standard emphasizes the crucial role of the "rules of the game" in international adjustments. In a deficit country, the central bank would use discount-rate policy and open-market interventions to raise interest rates and tighten credit. In the surplus country, it would lower the interest rate and expand credit. As a consequence, two components of the "rules of the game" should be observed in central banks' practices (Whale 1937, Nurske 1944, Bloomfield 1959): first, the central bank should raise the discount rate when their gold reserves decrease, and, second, central banks should not sterilize, that is, expand (or reduce) domestic assets to offset outflows (or inflows) of gold. The adherence to the rules implies that domestic assets of central banks are positively correlated with international assets but negatively correlated with the domestic interest rate.

The Banque de France, one of the main pillars of the classical gold standard along with the Bank of England and the Reichsbank,[1] continuously violated the two components of the rules of the games. First, the official discount rate remained flat. Such a peculiar behavior was the subject of many discussions by contemporaries in France and other countries alike and it has always been treated as a curiosity in the subsequent literature on French monetary policy under the gold standard (White 1933, Whale 1937, Bopp 1952, Nishimura 1995, Gallarotti 1995, Contamin 2003, Rodgers and Payne 2014)[2]. It strongly differed from the Banque de France policy under bimetallism – studied in Flandreau (2004)

[1] Gallarotti (1995, p.219) claims that the Banque de France was the true hegemon of the gold standard as it served as a lender of last resort to England in 1890 and 1906-1907.

[2] Whale (1973, p.20) argued that "It may be said that the Bank of France was able to avoid varying its discount rates because the country was only on a limping standard. But this point cannot be substantiated unless it can be shown that the exchange value of the franc fell below the gold export point for appreciable periods. Other special circumstances might be adduced in the case of France (e.g. the limited importance of credit money, in later years the size of the metallic reserve)." Other authors often only refer to the objective of a stable discount rate set by Napoleon when the Banque was created , or to national preference. Bloomfield (1959, p.24) only suggests that "and several of the banks, especially the Bank of France, referred to the relative stability and lowness of their discount rates as a measure of their achievements." See our discussion on this issue in Section 1.

- when the official discount rate changed frequently. In addition – as noted by Bloomfield (1959), Emanoil (1932) and White (1933) using annual data – the discount portfolio of the Banque de France varied negatively with gold flows in a systematic way between 1880 and 1913.

This article offers new evidence of these two deviations from the rules of the game and especially highlights the importance of the Banque de France's sterilization policy, which is much less known and documented. More specifically, we show that the Banque de France's credit to the domestic economy (discounts and advances) correlates negatively with gold flows because it correlates positively with the discount rate of the Bank of England. We discuss the conditions that allowed the Banque de France to run such policies and we explain why and how the objective of a stable discount rate led the Banque to use its domestic portfolio in order to neutralize the effects of gold inflows and outflows. We go beyond previous literature that has shown evidence that the rules were violated by French and other monetary authorities (Bloomfield 1959, Bordo and MacDonald 1997, Morys 2013) as we provide a complete examination of the mechanisms and adjustments that determined movements in the balance sheet of the Banque de France and made possible the disconnect between domestic rates and international rates, without intervention in the exchange market. Following the insights of Jeanne (1995)'s work on the Bank of England, we use VAR estimations to study the dynamic paths of national variables in response to international shocks. Our analysis is made possible by newly collected monthly and quarterly data on the Banque balance sheet and the French business cycle. We are able to estimate precisely the causes and the effects of central bank interventions, to disentangle domestic aggregate demand effects from external shocks and to look at differences between short-term adjustments and long-term relationships. We find that an increase in the English discount rate caused a fall in gold reserves of the Banque de France but pushed its domestic portfolio up such that gold outflows were almost completely sterilized. Results show that domestic adjustment to an international shock took place in a period shorter than a year. Conversely, such an international shock had no significant effect on the French business cycle (as proxied by imports and railway revenues). We show that the extent of sterilization of international shocks by the central bank explains these findings.

In a world of integrated financial markets and British leadership, the French money market interest rate was influenced by foreign, and especially British, rates. A rise in the Bank of England rate decreased the spread between the French money market rate and the Banque de France official discount rate. Facing higher demand for credit, the Banque could either increase its discount-rate or, conversely, increase its discount portfolio to expand domestic credit. The latter brought the spread back to its

previous level and maintained the official discount rate stable.[3] This is the crucial mechanism identified in this paper.

As expressed by Governor Pallain in 1908, the commitment of the Banque to discount commercial paper in order to ease the money market and keep the official discount rate stable was an essential component of French policy. Our econometric evidence strongly supports this argument and shows that this led to massive short-term adjustments in the Banque balance sheet in response to international shocks.

Our elucidation of adjustments that were necessary to keep the discount rate stable also offers a good explanation of the few changes in the Banque rate. The Banque discount rate was changed only in extreme cases when the previously highlighted mechanisms could not work fully. Thus the response of the Banque rate to main economic variables was highly nonlinear. We account for this non linearity in a regime switching model, in order to avoid the pitfalls of previous studies and we find that the Banque de France decision to change its discount rate was determined by the Bank of England rate, the gold stock and the deviation of the exchange rate from the gold point (Officer, 1992). Our interpretation in terms of regime shifts makes clear that the changes were infrequent because, in normal times, the Banque de France used all possible means to reduce the probability that these variables affected its decision to move the discount rate.

A better understanding of the policy of the Banque de France brings a better understanding of the classical gold standard. It is commonly argued that the Bank of England and the Banque de France were the two extremes of the spectrum of the monetary regime (Whale 1937, Bloomfield 1959, Gallarotti 1995). As Jaime Reis writes, “At one extreme of the spectrum was the Bank of England, with very low reserves and frequent changes in its rate to ensure that, despite gold drains, they were always sufficient. At the other was the Banque de France, with very large reserves and a preference for an immobile discount rate.” (Reis 2007, p.720). These opposite positions in policy are reflected in the liquidity ratios (metallic reserves divided by notes in circulation) of these countries: France had the higher ratio whereas England had the lower (Morys, 2013, table 3). While the objectives and interventions of the Bank of England under the gold standard have been studied extensively (Goodhart 1972, Sayers 1976, Dutton 1984, Pippinger 1984, Officer 1986, 1996, Davatyan and Parke 1995, Jeanne 1995), this paper is the first to provide a complete interpretation and account of the policy of the Banque de France. The monograph by HD White in 1933 on *French international accounts* focused on

[3] Before 1900, because of the insufficient volume of gold in the Banque de France’s vault, gold devices supplemented these operations. In some rare and extreme cases, the Banque de France intervened on foreign markets in order to prevent a further increase in international interest rates (Ramon 1929, Gallarotti 1995, Rodgers and Payne 2014).

annual trade flows (it was mostly speculative about the role of the Banque de France and was silent on the short-term adjustments highlighted in our paper), Bopp (1952) only offered a broad survey of the institutional and legal context of French monetary policy and Contamin (2003) focused on gold devices. Thus, an examination of the balance sheet policy of the Banque de France, which was the opposite of the Bank of England flexible rate policy, can provide new insights for the study of central banks which fell in between the two poles on the continuum. Overall, our approach adds new dimensions to the traditional view of the gold standard that assumes that central banks' discount rates and gold premia were the most important monetary policy instruments. Focusing solely on interest rates to study domestic policy objectives and international adjustments might be misleading.

The remainder of the paper is organized as follows. In section 1, we briefly review the literature dealing with the objective of a low and stable French discount rate. In section 2, we explain how the Banque de France used the gold premium (until 1900) and its gold stock to avoid following the official discount-rate of the Bank of England. Section 3 then shows that such a policy implied interventions of the central bank in the domestic money market in order to stabilize the spread between the market and the official interest rate. Section 4 discusses how our previous results imply that the reaction of the Banque de France discount rate to key international and economic variables was highly non-linear. Two regimes are estimated from a Markov switching equation. Section 5 concludes with general comments on the functioning of the gold standard.

1) Discount rate stability as a primary objective

The main singular aspect of Banque de France policy under the Gold Standard was to keep a stable official discount rate.[4] The difference with the Bank of England is especially striking, as shown in Figure 1. Such a difference in policies across the Channel was neither left unnoticed nor attributed to random idiosyncratic economic factors. The Banque de France never hid that a stable and low discount-rate was its primary objective and this was widely discussed within policy and economic circles (Neymarck 1889, Nitti 1898, Liesse 1910 p.212, Ansiaux 1910, and several other references quoted by Patron, 1910, p.27). In his history of the Bank of England, Sayers (1976) relates the “grumbles about

[4] As noted by Harry Dexter White: over this period, there were only 30 changes in the French official rate of discount as against 116 in the Reichsbank and 194 in the Bank of England (White, 1933, p.139). The average discount rate of the Bank of England and the Reichbank over the period were respectively equal to 3.4% and 4.2% while that of the Banque of France was equal to 3.0%. Also, while the Bank of England and the Reichbank discount rate standard deviations were equal respectively to 0.99 and 0.92, the Banque of France discount rate standard deviation was equal to 0.57. Even though the French official discount rate was on average lower than the British rate (by 0.4 points), the most striking difference is in the volatility of the rate.

frequent rises in Bank Rate and contrasts with the stable cheap money regime across the Channel" (p. 43) although the frequent debates in England on this topic did not necessarily lead to an admiration of the French system: "There was no consensus on whether a stable Bank Rate was to be preferred: Palgrave seems to have over-rated that attraction of the French system."(p. 44). Scholars who have studied the functioning of the gold standard have rightly emphasized that the stability of the French discount-rate should not be seen as evidence of superior economic policy or of greater financial development.[5] The stability of the French discount rate was a policy choice that implied constraints and procedures that were different from the British ones.

Banque de France management repeatedly stated that its public mission was to achieve a low and stable discount rate. Governor Pallain said in a January 1907 speech (Ramon 1932, p. 420) that the "essential function of the Banque de France is to keep a moderate and stable discount-rate." A year after, he stated at the board of the General council that: "In accordance with the traditional view of the Banque de France's council, [the Banque] aims to provide cheapest liquidity to national business."[6] In an interview with Aldrich for the US National Monetary Commission (Pallain, Aldrich 1908, p.215), he proudly stated: "The stability and the moderation of the rate of discount are considered as precious advantages, which the French market owes to the organization and traditional conduct of the Banque of France." Recent works on French central banking in the late XIXth century inform us as to the decision of the Banque de France to keep a stable discount rate. In particular, the Banque was a private institution with profit objectives. Competition with commercial banks – especially large deposit banks – led the Banque to keep low stable discount rate (most often 3%) to not be crowded out from the market (Baubeau 2004, Bazot 2014, Bignon 2013, Bignon and Jobst 2013). In addition, inside influence from the State, merchants and industrialists incited the Banque to stabilize interest rates to avoid volatility and then to support their businesses (Leclerq 2010).[7]

[5] "Yet Paris should not be thought of as the monetary center of the world, for this stability reflected the Bank of France's desire for steady discount rates, and her willingness to use other devices to discourage gold losses from its ample reserves, and not superior strength. London's rates were higher on average because the Bank of England preferred to use interest rates to check gold losses and to maintain a free gold market." (Ford (1962, p.21) See also Bloomfield, 1959, p.32.

[6] « Conformément au principe qui a toujours prévalu dans les Conseils de la Banque de France de donner l'argent à notre commerce national au prix le moins onéreux possible. » (ABF, PVCG, 23 janvier 1908)

[7] Bopp (1952) also notices that a stable discount rate was the main objective of the Banque de France from its creation by Napoleon, and that the Banque attempted to turn to a policy of flexible rates only from the 1850s to the early 1870s. Regarding the stability of the discount rate at 4% in the first half of the century, he said "I am unable to give a convincing analysis of how the Bank was able to maintain a fixed rate for such a long period. It is scarcely possible that 4 per cent was the "equilibrium" rate continuously from 1820 until 1847. In principle, however, a discrepancy between the two would have touched off cumulative inflation or deflation. Clearly, a 'hiatus should have developed between a fixed rate on the one hand and either convertibility or profits on the other. How was the gap filled?", p.233

Members of the General Council thought that this constraint implied two consequences: First, as explained by Governor Pallain in the interview mentioned above (cf also Liesse, 1910, p.212[8]), the Banque had to keep high metallic reserves in order to avoid raising the Banque rate systematically when gold was flowing out of the country: "It is a principle consecrated by experience that the supreme means of defense for an issue bank, to protect its metallic reserve, is to raise the rate of discount, and we never lose sight of this principle. However, the extent of our reserves allows us to contemplate without emotion important variations of our metallic stock, and we only exceptionally have recourse to a measure which is always painful for commerce and industry." (Pallain to Aldrich 1908, p.215)

Second, the Banque had to intervene such that the spread between the official Banque discount rate and the money market rate (*taux du marché libre*) did not vary too much.[9] The next sections will study each of these consequences in great detail.

2) Gold and gold devices

Supporting Pallain's claim, the standard explanation of the Banque de France policy under the Gold standard states that huge reserves allowed the monetary authorities to let gold flow out without following the increases in the Bank of England's discount rate (White 1933, Bloomfield 1959)[10]. Until 1900, the Banque de France also used gold devices (White 1933, Bopp 1952, Bloomfield 1959, Gallarotti 1995 p.48, Contamin 2003) such that an increase in foreign rates had a less adverse effect on the domestic gold stock. The Banque offered a premium on gold and could increase it when necessary to mitigate the demand for gold. The use of a premium on gold was possible because the Banque could legally redeem its notes in either French gold coin or 5 franc silver coin. Since the silver value of the latter was lower than the nominal value of the coin, the Banque had a strong control over gold sales: when the Banque wanted to discourage gold exports, it accepted to redeem its notes in silver only.

[8] "In fact, the Bank of France follows a different plan from the credit companies and private banks in general in the matter of discounts. Its rate is uniform, for the most part, and is modified as little as possible. The Bank can do this, thanks to a sufficient margin of issue and an imposing reserve. But this state of affairs does not give it the flexibility of the other credit establishments, which are quite right in not maintaining a fixed discount rate. This is even a leading distinction between the companies and the large department stores, to which they are often compared." (Liesse, 1910, p.212)

[9] Banque de France archives (ABF), PVCG, 14 mars 1895.

[10] According to the computations of Tullio and Wolters (2003, p.3), from 1880 to 1913 the gold stock of the Banque de France increased by a factor of 4.7 while that of of the Bank of England increased only by a factor of 1.3. 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 that 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 to 61.5% and that of the Bank of England fell from 12.5 to 8.6%.

Banks in need of gold for exports could then purchase bullion or foreign gold coins from the Banque de France only at a premium. The premium on gold sales was used to circumvent the law that prevented the Banque from redeeming notes in gold at a premium.[11]

Figures 1 and 2 provide some evidence on this strategy. Figure 1 shows that the discount rate of the Banque de France is very weakly correlated with the changes in the English and German discount rate. On the contrary, Figure 2 shows that the gold premium applied by the Banque de France in Paris followed closely the Bank of England discount rate. The Banque thus preferred to raise the gold premium instead of its discount rate to prevent gold's outflows.

2.1 VAR estimations: identification and specification

Since the history of French gold devices and gold reserves are well-known and documented in the literature, it is not necessary to review them in detail. But previous studies have not discussed the quantitative impact of these policies and its statistical robustness: to what extent did the Banque de France use its gold stock and gold premium to avoid raising the discount rate in response to international shocks? Is this effect large and statistically significant? In order to answer this question, we estimate a VAR system and simulate the effect of an increase in the Bank of England discount rate on the balance sheets and the instruments of the Banque de France. Jeanne (1995) has shown the usefulness of VARs to understand the nuts and bolts of the Bank of England policy under the gold standard. A VAR analysis is well suited since it accounts for the obvious endogeneity of the variables of the Banque de France balance sheet to foreign variables. Gold flows and interest rates were endogenous under the gold standard. The other advantage of the VAR methodology is that we can impose short-term structural identification in order to isolate an exogenous short-term shock on the French economy. We use such structural identification to study the impact of an exogenous increase in the English discount rate (the Bank rate) on the French economy and the policy of the Banque de France. According to the rules of the games, this should lead to an increase in the Banque discount rate aiming to offset the decrease in the gold stock.

[11] Based on various sources, White (1933, p.186) also documents two other gold devices used by the Banque de France. It could raise the export point by requiring the banks demanding gold for export to discount long-term bills in excess of the amount of gold demanded. It could lower the gold import point by crediting importers of specie from the date of shipment rather than the date of receipt or accepting gold at branches in seaports rather than in Paris in order to decrease shipment costs. Based on our reading of the archives of the Banque, we follow White in saying that there is no evidence that these devices were used frequently and that they had major quantitative consequences.

The VAR is estimated with data in log levels in order to account for some implicit cointegrating relationships in the data.[12] The Bank rate is ordered first in the VAR such that we identify (through a Cholesky decomposition) an international shock as a shock to the Bank of England rate that affects contemporaneously the French economy but which is, in return, affected by the French economy with a 1 month lag. Studies using VARs usually refer to this structural shock as "exogenous" or "unsystematic" (Christiano et al. 1999). This identification procedure is common in the literature that identifies monetary policy shocks in fixed-exchange regimes and is straightforward in the case of the Gold standard due to the international role of the Bank of England. Such an assumption means that a simulated shock to the Bank rate is an unsystematic shock that is not explained by the current value of the other parameters of the model affecting the Bank rate (including French gold and French rates). An immediate response of the Bank of England to a Banque de France decision is thus not defined as a shock in our model (but our assumption does not imply that such a response did not happen). Formally, it means that the international shock, ϵ_t is defined such that the Bank rate at time t, B_t is the following function:

$$B_t = f(Y_{t-n}) + \epsilon_t$$

where Y are all variables in the VAR (including past values of the Bank rate).

$$Y_t = A_1 Y_{t-1} + A_2 Y_{t-2} + \cdots + A_n Y_{t-n} + C\eta_t$$

and C the contemporaneous impact matrix of the η_t mutually uncorrelated disturbances. Our identification assumption means that the international shock ϵ_t is the first element of η_t. Thus, an increase in B_t, due to an increase in ϵ_t is a policy decision of the Bank of England which is not explained by past French variables; thus, it is interpreted as a short-term term exogenous international shock to the French economy.

We use monthly data in order to include a sufficient number of variables in the VAR and to keep the recursive identification relevant. The variables to be included in the estimation are the following: the Bank of England discount rate (hereafter "Bank rate"), the exchange rate between London and Paris, the Banque de France discount rate (hereafter "Banque rate"), and the Banque de France gold premium in Paris. These variables are obvious candidates since these are prices that are supposed to determine gold and money flows. The Reichsbank rate will be used for robustness analysis in order to

[12] It is worth noting that we also ran the VAR using variables in first differences as in Jeanne (1995) to fully account for cointegration issues. Results show no difference with the log-based analysis, suggesting that the log-based analysis must be preferred due to its interpretation superiority.

check that the Bank of England rate is the main driver of international shocks. In addition, we include variables of the balance sheet of the Banque de France: gold stock, silver stock and a liquidity ratio (or cover ratio). The latter is used in the literature (Goodhart 1972, Tullio and Wolters 2003, Morys 2013) based on the rationale that the objective of the central bank was to maintain a stable proportion between metallic reserves and notes in circulation. We define it as equal to *(gold stock + silver stock) / notes in circulation*. Last, we include some general indicators of French economic activity.[13] There is no monthly or quarterly series of the French money supply and gold circulation, but we have the excess of specie imports available from trade statistics and published in White (1933).[14] It is exclusive of silver bullion and expressed in millions francs. Next we need to control for the French business cycle. A common practice is to use discounts of commercial paper as a proxy for aggregate demand (Baubeau 2004). But total French discounts are available only annually, and the discounts of the Banque de France are mostly a policy variable rather than a simple proxy for business activity as we will show in Section 3. Thus we use imports as a proxy for French aggregate demand (as in Bordo and MacDonald 2005). This series is available monthly but is not perfect although we control for the exchange rate in our estimations. In order to check the robustness of our results, we have constructed the first index of French economic activity based on railway revenues available for the whole period (1880-1913).[15] We explain in the Appendix how this series was constructed and we present the sources of the data. We will show below that using imports or railway revenues does not modify the main results of the estimations and our interpretation of the Banque de France policy.

In Section 3, we will add variables from the asset portfolio of the Banque and the Parisian money market in the VAR without affecting the results presented in this section.

[13] Monthly or quarterly price index series are not available in France before 1899. Nevertheless, a VAR using post-1899 data to account for price effect does not affect the results. Results are available upon request from the authors.

[14] Based on a careful study of French trade and gold circulation, White (1933, p. 172) found that "the Bank of France was virtually the sole depository of the specie reserve of all the French banks ; specie imported into France went either into vaults of the Bank of France or into hand to hand circulation. Throughout the period under survey specie imports were in excess of specie exports. " Sicsic (1989) also states that the trade statistics of metal imports and exports are not reliable and miss important flows (especially from coins brought by travelers). These flows are certainly too important to propose a reliable estimation of the French outstanding gold circulation, but, despite these flows, trade statistics may provide interesting information to estimate the changes in gold flows after a change in foreign discount rates.

[15] Railways revenues have been used as an indicator of economic activity in several analyses studying the gold standard in the UK and Germany, including Goodhart (1972), Jeanne (1995) and Bordo and McDonald (1997, 2005). Our series of railways revenues shows a strong correlation with annual series of French activity. The correlation coefficient between annual railways revenues and annual GPD is 0.94. The correlation coefficient between deflated annual railways revenues and annual industrial production is 0.85 For imports, these numbers are 0.74 (GDP), 0.84 (Ind.prod) and 0.82 (Agr. prod) respectively. The correlation between deflated GDP and industrial (agricultural) production is 0.79 (0.82) only. Annual data is from Saint Marc (1983).

2.2 The role of gold reserves and the gold premium

We estimate the VAR and compute structural impulse response functions of variables to a one-standard deviation shock on the English Bank rate using the Cholesky decomposition described above. Figure 3 presents the results of the estimation of a large scale 8-variable VAR.[16]

A one-standard deviation shock increases the Bank rate by 0.4 percentage points. Such an increase in the English discount rate pushes up the exchange rate (i.e a depreciation of the franc) and has strong effects on the policy of the Banque de France. It mostly affects the Banque gold stock and the gold premium of the Banque. The former falls immediately and is decreased by 1.5 percent after 4 months when the latter increases immediately by 0.3 percentage points (in a rather similar magnitude to the Bank rate, as already observed on Figure 2). The magnitude of these effects is important since the Banque kept a large gold stock. For example, in 1900, from a gold stock of 2000 million francs, 26 million would have flowed out of the Banque 4 months after a 0.4 percentage points increase in the English rate.

French excess specie imports fall immediately by 5 million francs. After 4 months, 23 million would have left France, that is around 90% of the amount that had flowed out of the Banque of France[17] Indeed, gold flows caused by international shocks were explained by arbitrage between countries and thus involved balance of payments movements. Not surprisingly, the response of the official discount rate of the Banque de France is extremely moderate and only weakly significant. This is because (as shown in Figure 1) the Banque did not systematically increase its rate after a rise in the English rate. Estimating the VAR with the liquidity ratio (Figure 4) provides similar results as with the gold stock: after 3 months, the liquidity ratio is 1.3% below what it would have been without the shock. In Section 3, we will discuss why gold flew out but the amount of notes in circulation remained constant.

The results of the VAR estimations confirm our expectations and previous knowledge on the mechanisms at work during the gold standard. A rise in the English rate depreciates the franc and gold flows out of the vaults of the Banque de France. It implies that the higher the gold reserves, the less it is necessary to increase the discount rate since gold outflows would finally stabilize the exchange rate. The impulse response functions estimated from the VAR also make clear that the Banque used gold devices rather than its discount rate to mitigate gold exports.

[16] We use 12 lags for each variable. This choice is confirmed by the AIC criteria and leads to more precise estimates than specifications with shorter or longer lag-length. Our conclusions are not affected by the use of more lags.

[17] Note that excess specie imports are not in log levels in the VAR but in millions (because they can take negative values). Thus, the reaction function of this variable in Figure 3 is not cumulative.

2.3 The speed of adjustment and the (non)role of silver…

Our estimations offer further insights on the nuts and bolts of the central bank's adjustment to international shocks. First, the average time of the adjustment is robust across specifications and is equal to about 10 months. The effects on the exchange rate, gold stock and gold premium are all non-significantly different from zero ten months after the shock. The persistence of the effect of a monetary policy shock on the French economy during the gold standard is shorter than the one observed in subsequent periods (Mojon 1998, Monnet 2014) where the effect could be maximal 20 to 25 months after a shock. Markets and central banks all adjusted very quickly during the gold standard. Consequently, previous studies using annual data (White, 1933, Bloomfield 1959, Baubeau 2004, Bignon 2013) could not observe and account for short term (less than a year) adjustments in response to international shocks

Second, the adjustments worked through gold and not through silver. This result contrasts with the role attributed to silver in late XIXth century France by economic historians (Bloomfield, 1959, p.54, Flandreau 1996, Contamin 2003). Silver did play a role in the French economy during the gold standard and the Banque de France always kept a fair amount of this metal as shown in Figure 5: the Banque sold silver in order to acquire and accumulate gold (Sicsic 1989), and, more important, the ability to redeem notes in silver allowed the Banque to use gold devices. But the results of our estimation rule out the hypothesis according to which silver flows could have played an important role in mitigating the effect of international shocks on the French economy. The redemption of notes in silver played at best an extremely small role in the violation of the rules of the game.[18]

The absence of any major effect of the Bank rate on silver holds when we divide the sample in two parts, pre and post 1900, the year when the amount of silver and gold in the Banque vaults started

[18] Pallain (1908, p.216) suggests that this was used in extreme circumstances only "The Bank of France cannot, of course, renounce its right to redeem its notes in gold or in silver, since gold pieces and silver coins of 5 francs are equally legal tender in France. But it only uses this right with discretion and to the extent that it appears necessary in order to prevent an unjustifiable weakening of its reserves. In no case, however, whatever may have been said, have we ever charged any premium on French gold in redemption of notes." In the minutes of the General council of the Banque, we have found reference to this strategy only in 1880. Debates at the time within the Banque suggest a clear strategy to build high gold reserves and to let the silver stock decrease.
(PVCG, 29 July 1880).The Banque also looked closely at the circulation of foreign silver coins, especially from Belgium and Italy (countries from Latin Union) and wanted to keep them in circulation because it knew that these stocks would not help to pay foreign bankers asking for gold when the Bank of England was increasing its rates. (Ex: PVCG, 15 mars 1883, 8 décembre et 20 decembre 1887, 9 février 1888, and many sessions during the 1890s, 9june 1892 etc.). The number of foreign coins in the Banque de France balance sheet thus decreased over time, cf. Sicsic (1989, p.721 et al.)

to diverge greatly. The response of silver is more significant and stronger – though still very small - after 1900 (Figures 7 and 8) because the stock of silver has fallen (a similar drop in volume creates a higher decrease in percentage in the second part of the sample). These estimations also show that the percentage decrease in gold was similar across subsamples (around 1.5% after 3 months). Conversely, the gold premium had stopped playing a role in 1900. Since the nominal value of the gold stock was on average twice as high in 1900-1914 compared to 1880-1900, we conclude that the decrease in gold caused by a similar increase in the English Bank rate was – on average – twice as high after 1900. This result clearly confirms that the gold reserves of the Banque de France played a more important role after frequent use of the gold premium was abandoned in 1900 (White 1933, Contamin 2003).

2.4 Robustness: quarterly data and the German rate

In order to provide evidence of the robustness of our previous results, we now check that they hold with quarterly data when using the railway revenues as a proxy for aggregate demand. Then we discuss the respective role of Germany and England in influencing Banque de France policy. Figure 9 shows that the pattern and magnitude of the response functions is similar in a VAR estimated with quarterly data and when railway revenues replace imports as a proxy for economic activity. Interestingly, it also provides further evidence that an increase in the English Bank rate had no negative effect on the French business cycle, despite large gold outflows and a fall in the liquidity ratio. Such a conclusion is important as the absence of short term effects of foreign monetary policy on domestic activity despite the fixed exchange rate may contribute to explain why the gold standard lasted for 35 years without losing public support. The next section will show that the sterilization of gold outflows through the Banque de France portfolio was crucial to this result.

Was the Bank of England discount rate the main cause of Banque de France gold movements? Did the Reichsbank also influence Banque de France policy? Crucial to our results is the identification assumption made in the VAR that Bank rate affects contemporaneously the French economy but with a lag. When we introduce the Reichsbank rate in the VAR with the assumption that it is contemporaneously determined by the Bank of England rate, we find no effect of the Reichsbank rate on French economic variables (Figure 10). A shock to the Bank rate has the same effects as in previous estimations. Making the opposite assumption (Figure 11) – that is the Reichsbank rate immediately affects the Bank rate but the latter affects the former with a lag – we find that a shock to the Reichsbank rate has a small effect on the Sterling-Franc exchange rate and on the gold premium but the effect on

the gold stock is similar as with a shock to the Bank rate. In other words, making the heroic assumption that the Reichsbank was the leader of the gold standard and that English policy adapted to German policy, we still find an effect of Bank rate on Banque de France's balance sheet, but the reverse is not true. These results confirm that the Bank of England was the main player of the gold standard and that its discount rate was the main factor influencing French gold flows. As a consequence, it is sufficient to consider Bank rate shocks as a proxy for other international shocks in VAR estimations.

Another robustness check would be to include a price index in the VAR. No monthly or quarterly price index is available for France before 1900. At this date, an economic newspaper (la *Réforme économique*) started to publish a wholesale price index including only a few commodities. VAR results described previously do not change when we use this monthly index in the estimation after 1900. The absence of a role for prices is consistent with the principles of the gold standard according to which the difference of prices between countries remained fixed and inflation was low and stable.

2.5 From gold devices to the foreign assets portfolio

In order to keep its discount rate stable, the Banque de France could let gold flow out of the country so that it pushes the exchange rate back to parity. The VAR shows that these mechanisms were at work and that their magnitude was massive. In terms of gold, this policy was much more costly than raising the discount-rate but the Banque de France choose to let gold reserves diminish rather than restricting the credit supply through an increase in the discount rate. As described previously, the Banque de France justified its preference for interest rate stability over gold stability in saying that the French economy was averse to interest rate changes. Nevertheless, the next section will show that the ability to sterilize these outflows was essential to this policy. The use of gold reserves to avoid an increase in the discount rate was more important after 1900 since gold reserves were high enough to abandon the unpopular and controversial gold premium. In fact, members of the General Council, prominently the Baron Alphonse de Rothschild, emphasized the perverse effect of the gold premium[19]. Rothschild (ABF, PVCG, december 1886, 13 septembre 1888, PVCLP tome 006, 14 octobre 1898) turned critical of this policy because it implied that if the discount rate had to be increased anyway, gold devices delayed the increase of the discount rate too much and, then, led paradoxically to a higher increase in the discount rate relatively to what would have been otherwise necessary. Thus, the perverse effect of gold devices was to make a rise in the discount rate more difficult to accept by the public – and thus

[19]Contamin (2003) already pointed out these motivations.

less credible. From 1886 to 1898, Rothschild and the Haute Banque favored an increase of the discount rate whereas the Governor favored adjustments through the gold premium. The *Haute Banque* feared a loss of credibility of the Franc due to the reduction of outstanding gold. They also argued that the gold premium could disconnect French markets from international markets and thereby make the Banque a non-cooperative player[20]. Once the gold stock of the Banque had reached a sufficiently high level in 1900, the Banque decided to give up the gold devices policy and to use only the discount rate when gold flows were not sufficient to restore the equilibrium.

One of the potential consequences of the end of gold devices and the increase of the gold stock, was the development of Banque de France interventions in foreign markets after 1900. Bloomfield (1959, p.56) describes this policy as "cooperation between central banks". In fact, it started in 1890, during the Barring crisis, when the Banque de France sent gold to England against 3-month Treasury bills, and it had already occurred several times before the gold standard in 1825 and 1836 (Flandreau 1997, Bordo and Schwartz 1999). Nobody has better explained the rationale of such a policy than Governor Magnin who decided to implement it: "We avoided the threat of a monetary crisis in England, which would have impacted the French market and thereby obliged the Banque de France to increase its discount rate" (Ramon, 1932, p.400).[21] Starting in 1906, the Banque started to manage a portfolio of foreign assets for this purpose. Exceptional interventions on the foreign markets (mainly on the London market) became more common starting 1906 (Ramon 1932, White 1933, Bopp 1952, Sayers 1976, Gallarotti 1995, p.80-85, 130-131, 140, Flandreau 1997, Contamin 2003, Rodgers and Payne 2014) and followed an increase in the Bank of England discount rate, usually with a 1 month lag (figure 12).[22] This portfolio was notably used to end the US financial crisis in 1907 (Rodgers and Payne, 2014).

[20] PVCG of 20/11/1886: "Mr Rothschild cites an article of *Le Temps*, which, following the New York crisis and its effect in London, seems to believe that the Banque de France has no solidarity with London and only provides gold when it concurs with its own terms, regardless of the effect it can have on the English exchange rate."

[21] This operation was actually initiated and mostly organized by the Baron Alphonse de Rothschild. He played the intermediary and managed to convince the Conseil Général that cooperation was needed (ABF, PVCLP, 10 November 1890). The Bank of England asked the Banque de France to help. At the board of the Banque de France, Alphonse de Rothschild explained that he had received such a demand and justifications from the English branch of the Rothschild family and that cooperation was crucial for the interest of the monetary system and the Banque de France. Some members of the board were reluctant to lend to England because they wondered whether the Banque de France would be repaid in case of a Franco-English war.

[22] Because the discount portfolio is not used before 1906, it has not been included in previously reported VAR estimation. However, introducing this variable in the estimation does not affect the results. Notice that, the discount portfolio responds positively but insignificantly to an increase in the BoE discount rate. Significance is obviously biased by the fact that the discount portfolio is set to zero till 1906.

The role of the foreign portfolio to stabilize foreign market rates and then the domestic discount rate has already been highlighted in the literature[23] but, it is better understood if we know how the Banque de France used its domestic portfolio in order to stabilize the domestic rate. Surprisingly, these domestic operations and their effects, although at the core of the operations of the Banque, have received very little attention in previous studies (and much less than the international portfolio…). The next section attempts to fill this gap.

3) Banque de France credit to the economy and the money market rate

The consequences of the stable discount rate policy for Banque de France interventions on the domestic market can be viewed on a graph that displays the Banque domestic asset portfolio (discounts and advances) and the Bank of England discount rate (Figure 13). Although the correlation is not perfect since demand for Banque discount also had pure domestic causes, it is noteworthy that all the increases in the English Bank rate correlate with an increase in the discount portfolio of the Banque de France.

3.1 What do we really know about the link between international reserves and domestic assets?

Since an increase in the English rate also drained gold out of France, Figure 13 is consistent with an overall negative co-movement between domestic and international assets that was observed by Emanoil (1932), and White (1933 p.198) and interpreted by Bloomfield (1959) as a violation of the rules of the game. Such a negative co-movement was actually well known at the Banque de France since Governor Pallain replied to Aldrich 1908 (p.212) in the following way:

[23] In addition to the reference quoted above, Flandreau and Gallice (2007) highlighted the impact of this policy from a private bank perspective: : "The Banque de France, in order to prevent the Bank of England from pushing them too high, went out buying in Paris whenever the French banks started selling their sterling bills portfolios. This is well illustrated in Fig. 5.8, which shows the negative correlation existing from 1906 to 1913 between variations in the Paribas bills portfolio and the portfolio of the Banque de France when Paribas sold, the Banque de France bought. As is apparent, changes in Banque de France sterling holdings reacted to changes in the Bank of England discount rate as if the Bank of France had sought to maximize profits. Thus, paradoxically, the variations in the French bank of issue's bills stock were much more consistent with British interest rate changes than were those in our private bank's bills portfolio. This is because, we argue, private banks mostly bought London bills for liquidity purposes and were thus irresponsive to interest rate differentials."(p.99) Section 3 shows that the paradox identified by Flandreau and Gallice about the portfolio of foreign assets provides a good characterization of the Banque portfolio of domestic assets during the whole period.

"Aldrich: Does the export of gold reduce the volume of notes?
Pallain: Not necessarily. It may happen that among our assets a certain fraction of the gold is replaced by an equal amount of bills in our portfolio, and that without changing the total of notes in circulation."

However, the negative correlation between domestic and international assets is far from airtight since it is not observed for all frequencies, as already noted by White and Bloomfield. According to these authors, it is mostly visible at an annual frequency. With annual data, the correlation is not statistically significant however, but the graph suggests there is a negative co-movement indeed (Figure 14). Looking at the raw correlation in monthly data between the logs of central bank credit and gold stock, we find a positive number (.053), rather than the negative sign documented by Emanoil, White and Bloomfield. The correlation between the changes in these two variables – still with monthly data - is a small non-significant number, 0.17, with a standard error of 0.13. With quarterly data, the correlation between changes is significant but small (0.05, with a sd of 0.01).

Hence, previous studies which have documented a negative co-movement based on simple descriptive statistics and graphs have provided only limited robust evidence to relate this co-movement to an active policy of the central bank. We were not able to find strong support for this theory based on simple correlations.

More generally, there is little attention devoted to how central banks exploited this negative correlation to violate the rules of the game: how often did it happen and how long did it last? What did Pallain mean by "Not necessarily" when he replied to Aldrich's question about the expected positive correlation between notes and gold? As already noted by Jaime Reis (2007), a rare – but still quite general - case study is in Eichengreen and Flandreau (1997, p.17), who state: that "Although it was possible to find repeated violations of rules over periods as short as a year, over longer intervals central banks' domestic and foreign assets moved together".

Moreover, Bloomfield's view that this negative correlation is evidence of the violations of the rule of the game has not remained unchallenged. As suggested by the proponents of the monetary theory of the balance of payments (Johnson 1973, McCloskey and Zecher 1976, Sommariva and Tullio, 1987, 1988), there is another possible interpretation of this negative relationship. Contrary to Bloomfield's assumption, the direction of causation can run from changes in domestic assets to endogenously determined changes in foreign assets. If there is a positive deviation of domestic production from trend, the demand for credit at the central-bank increases. In the short-term, such an increase puts pressure on the interbank money market rate, and, then, the spread between the interbank rate and the money market rate decreases. In order to ease the market, the central-bank provides more

credit and thereby pushes down the interbank rate, leading to gold outflows. Sommariva and Tullio (1987, chp.2) found some evidence of such a mechanism in Germany during the Gold standard (1880-1913).

Given the observed correlation between the English rate and the Banque de France portfolio (Figure 13), it is unlikely that the monetary theory of the balance of payments explains all variations in Banque discounts, except if we are willing to assume that the French business cycle had a major influence on the English interbank market (or that it is influenced by a common international business cycle). Nevertheless, a proxy for economic activity must be included in the VAR in order to account for this potential effect. Note that the influence of domestic demand on the Banque de France supply of credit can be important without implying a balance of payments effect and, thus, can be related to domestic assets of the central bank but not to the English rate and the gold stock. We will test for both hypotheses.

Did the Banque de France use its balance sheet (namely domestic assets, i.e discount and advances) to sterilize gold outflows in response to international shocks? Setting an interest rate is not enough to maintain rate stability. Interventions are needed to avoid a too narrow or too high spread between the central bank and the interbank rates and thus keep the Banque rate effective. The alternative theory (monetary theory of the balance of payments) states that the Banque was not involved in this kind of activity and that the movements in central bank assets and liabilities are mainly explained by domestic aggregate demand. Before attempting to answer this question using VAR estimations, it is useful to explain in greater detail the data on the money market rate and the domestic portfolio of the Banque de France.

3.2 The French money market and the Banque de France portfolio

As explained in Roulleau (1914, chp. VIII) and White (1933, chp. IX), the Parisian money market rate reported by the *Economist* was a composite of the rates at which the largest merchant and commercial banks bought some of the best paper in the Parisian open-market. Most discounting in France was done at the Banque discount rate or slightly below, but a small part of commercial paper (traded by the best and most well-known banks) was discounted at a lower interest rate. This market was relatively small although we do not have any precise evaluation of its size. And the spread between the market rate and the Banque rate was usually low compared to the English spread (an average of 0.5 percentage point

over the period). Thus, it was deemed a good indicator of credit conditions in France by contemporaries (Neymarck, Liesse, Aupetit, Ansiaux, Roulleau) and by the Banque de France. [24]

Research by Flandreau and Sicsic (2003) and Ungaro (work in progress) on the *reports* market has also shown that the rate published by the *Economist* was a good indicator of credit conditions. Figure 15 suggests that the Parisian money market rate was correlated with the English Bank rate (and thus to the spread between the official Banque rate and the money market rate since the former was stable)

The four graphs on Figure 16 present the main trends in the composition of the Banque de France balance sheet. The domestic asset portfolio increased over the period in the same way as the metallic reserves. The composition changed slightly as the proportion of advances increased relative to the rest, but discounting remained the main lending operation. A striking picture is the parallel evolution over time of credit in Paris and credit in branches. On the liabilities side, the deposits did not increase much. The expansion of the asset side was financed mostly by the increase in outstanding circulation as shown by the stability of the liquidity ratio over time (Figure 6)[25].

The Banque de France was a true pillar of the French banking system of that time as most banks depended on its liquidity provision for their usual business. In other words, each time banks were short of liquidity they could ask the Banque de France to rediscount their bills[26] or make an advance on securities[27]. Due to the large network of Banque de France branches, any bank in the country could thus have access to these facilities. Such liquidity insurance had some consequences for the money market. First, it stabilized supply and demand of liquidity and thereby kept the money market rate at a "normal" level, that is, below the Banque discount rate. Should the money market rate be too close to

[24] An 1895 discussion (PVCG 14 mars 1895) – that led to a decrease in the Banque discount rate – makes clear that if the volume of discounts decreased and the spread between the money market rate in Paris ("le taux du marché libre") increased too much – i.e. the market rate being way below the official rate – the Banque de France felt that it had to decrease its rate.

[25] Contrary to England, France had no law requiring notes to be covered by a certain proportion of gold. But the government set a ceiling on the outstanding notes in circulation. The Banque de France was aware of the adverse effect of large reserves on money circulation and thus on economic activity. Thus, the maximum legal limit of coins and notes issuance was an issue as long as the gold stock was increasing. The ceiling was increased in 1884, 1897 and 1905. Debates took place between the government and the Banque. The increase in this limit was thus complementary to the gold policy.

[26] Bank lending at that time was mainly made up of short-term discount operations, of which the basic form was: first, the drawer (e.g. a producer) issues a bill to the drawee (its client). Once issued the bill can circulate and be endorsed by different persons and enterprises. For instance, if the drawer needs liquidity he can ask a bank to discount the bill. By the same token, the bank can re-discount the bill to another bank or to the central bank, which then becomes an endorser. At the end of the process, the entity to which the money is paid is called the payee. At the settlement date the payee asks the drawee to pay the face value of the bill. If the drawee fails to pay, the joint liability rule applies and the payee asks the last endorser to pay instead. If the last endorser also fails to pay, the payee applies to the previous endorser and so on.

[27] Advances on securities played the same role as rediscounting even though they entail higher interest rates (usually 1% higher than the discount rate). In this case the Banque provided liquidity to the borrower in proportion to the value of securities. Securities are thus used as collateral and can then be sold on the market in the case of failure of the borrower. The Banque only accepted the most reliable ones to protect itself against drops in market value.

the Banque discount rate, banks could find it advantageous to discount their bills in the Banque de France, thereby increasing the amount of liquidity available and reducing the money market rate. Second, because the amount of funds invested on the market depended on investors' anticipation of the bills liquidity, the liquidity premium depended on investors' anticipation of liquidity constraints. By increasing the provision of liquidity the Banque de France sent a positive signal to investors who maintained their demand for bills. Hence, the spread between the central bank and money market rates should decrease after an increase in the Bank of England rate but decrease as long as the Banque de France is lending more to the domestic economy.

Although the money market rate is mostly a Parisian discount rate, we think it is necessary to consider all domestic assets to investigate the extent of the possible Banque de France sterilization. As France was financially integrated during the gold standard and the Banque had a large network of branches within the country (Nishimura 1995, Bazot 2013), the Parisian rate is a reliable proxy for credit conditions in France and Banque de France interventions could affect directly these conditions (Roulleau 1914, chp.VIII). However, as suggested by the parallel evolution in Figure 16, our conclusions are similar if we use only advances and discounts in Paris.

3.3 VAR estimations: the extent of sterilization

We now turn to the results of VAR estimations. Identification assumptions, data and specifications are similar to the ones in Section 2. We add the spread (in percentage points) between the Banque discount rate and the money market rate (the spread falls when the money market rate increases and the Banque rate remains constant) as well as a variable named "CREDIT_BDF" (in log level) that is the sum of all discounts and advances of the Banque de France. Described previously, we investigate the responses of the French economy and Banque de France policy to a shock in the Bank of England discount rate.

The results in Figure 17 first show that adding these two variables does not modify the conclusion of the previous section: the exchange rate and the liquidity ratio react exactly in the same way. Most of all, after a positive shock to the English Bank rate, the spread decreases immediately and the Banque de France increases its loans to the French economy. It goes back to normal after 7 months. The magnitude of the increase in Banque de France credit (between 1.5 and 2 %) is a bit higher than the decrease of the liquidity ratio and gold stock. Since the gold stock was on average 1.5 times bigger than the asset portfolio, it means that the Banque was almost completely sterilizing the gold outflows: according to these figures, an increase of the Bank rate by 0.4% in 1900 would have caused – after 3

months – a loss of 35 million in gold and an increase of 30 million of Banque de France loans to the economy.

The large magnitude of sterilization is confirmed by other estimations whose results are shown in Figure 18. If we simulate a one standard deviation shock on the Banque de France gold stock in the VAR, it increases by 2.5 percent after 3 months and Banque de France credit to the economy drops by 4 percent. The spread decreases as well. Figure 19 turns the mechanism the other way round: a positive shock to the spread increases the gold stock, appreciates the franc and lowers Banque de France credit to the economy by a similar extent.

VAR estimations whose results are reported in Figure 17 also include the yield of 6-month French Treasury bonds. Such a variable is added in order to discuss whether the willingness of the Banque de France to expand its credit to the economy after an increase in the English discount-rate could also have been motivated by needs to decrease the cost of government financing (as suggested in Ramon, 1932). The 6-month bond rate increases by 1 percentage point after an international shock – though not immediately – and goes back to normal after 8 months. Thus, Banque de France interventions eased both the private and public credit conditions that had deteriorated after an exogenous increase in the English bank rate.

3.4 Testing an alternative explanation: the monetary theory of the balance of payments

Thus, the results of the VAR estimations offer a consistent story of the behavior of the Banque de France domestic assets after a shock to the English Bank rate. We have interpreted our findings as evidence of full sterilization by a central bank whose primary objective was to keep a stable domestic official discount rate. Previously suggested, the monetary approach to the balance of payments provides an alternative explanation however. In order to prove that the negative correlation between the domestic assets and the international reserves of the central bank is indeed caused by international shocks, we need to provide further estimations.

First, as in Section 2, we estimate – rather than a monthly VAR with imports – a quarterly VAR that includes railway revenues as a reliable proxy for aggregate demand. If the spread and gold flows were primarily determined by aggregate demand, a Bank rate shock should have very little impact on these variables. This is not what we find (cf. Figure 20): the impact of a shock to the Bank rate on gold, the spread and Banque de France credit is similar if railway revenues are included or not in the VAR. Results of VAR estimations with quarterly data and railway revenues are entirely consistent with previous conclusions and interpretations.

Finally, we test directly whether a shock to railway revenues had an effect on the spread, the liquidity ratio (or gold stock) and on Banque de France credit. We identify a revenue shock as a shock to railway revenues that affects immediately these three variables but is not affected by them. Such an identification assumption should imply an increase in the spread and in gold reserves if the monetary approach of the balance of payments is correct. Figure 21 shows that there is no effect of an increase in short term activity on the spread and only a very small decrease in the liquidity ratio (0.3 percent). There is a quite strong effect on Banque de France credit (an increase by 5% in railway revenues led to a 1.5% increase in Banque de France credit to the economy), but this effect is not related to movements in the spread and very weakly to gold flows. Hence, in addition to sterilizing gold outflows, the Banque de France was responding to domestic demand, but these two activities were separated, contrary to what the monetary theory of the balance of payments would predict.

3.5 Central bank's assets and the stock market

In the previous discussions and estimations, we have assumed that the response of the Banque de France balance sheet to an international shock was not influenced by the behavior of the French stock market. However, in a way to keep sound banking business and to prevent stock market movements from jeopardizing investment banking activities of the Parisian *Haute Banque*, the Banque may have been incited to account for stock market movements in its policy decisions. One could thus argue that the main use of central bank assets was to support the activity of the Parisian stock market (the domestic portfolio would thus expand when stock market prices go down), which was itself affected by the English interest rate. If true, what we have interpreted so far as the response to an international shock would actually be partly the response to a shock of French stock market activity. The straightforward way to address this issue is to include a stock market index in the VAR. We use the monthly index of Le Bris and Hautcoeur (2010) which includes the stocks of the 40 largest firms listed on the official Parisian stock market. This index could be transformed in several ways in order to obtain a proxy for stock market stress or stock market cyclicality to which the central bank may have responded. Hence we use 3 alternative variables: the log of the stock market index, the cyclical component of the index (detrended through an HP filter) and the 3-month moving variance of the index (as a measure of volatility). We estimate a 9-variable VAR including all the previous variables of interest and we find that none of the three stock market variables changes the results obtained and discussed in the previous sections. Figure 22 shows the impulse response functions of the VAR that includes the cyclical component of the stock market index (STOCK_MARKET_TCI). Similar results

are obtained with the log-level of the index or with the measure of volatility.

Then we go further in the exploration of a potential relationship between the stock market and the central bank's portfolio as we simulate the impact of a shock on the stock market index. In Figure 23, we display the responses of the variables to an increase from the stock market index trend. No significant result is found. The only significant response in Figure 23 is the one of the spread between the Banque rate and the money market rate but it is extremely small and, furthermore, it is not observed when we use the log or the volatility of the series.

These findings go against the argument that the portfolio of the central bank could have been used mainly in response to financial instability. It does not mean that the Banque de France never eased money market financing in response to a financial crisis (it is well known that it was done during the 1882 and 1889 financial crashes)[28] but it means that it was not a systematic policy, contrary to the sterilization of international shocks described previously.

3.6 Summary

We have provided further evidence that the rise in Banque de France credit after a shock to the English Bank rate should be interpreted as full sterilization of international shocks by the Banque de France rather than as a consequence of the monetary theory of the balance of payments. These results cast new light on how Banque de France policy was constrained by the objective of stable and low rates. Because of full capital mobility, a shock to the English rate transmitted immediately to the French interbank market. As a result the spread between the interbank rate and the official discount rate increased, putting pressure on the Banque de France to increase its rate or to discount more commercial paper. Use of the discount portfolio in reaction to international shocks was thus key to achieve the objective of a stable and low discount rate. The VAR estimations show that the gold stock and gold devices were essential to avoid a further increase in the discount rate but they were not sufficient. The conclusion is that the objective of a stable discount rate forced the Banque de France to extensively use its balance sheet to sterilize international shocks.

High gold reserves, a stable discount rate and an expansion of domestic credit in response to international shocks, were the triptych of Banque de France policy. They complemented each other and none could work in isolation. International adjustments did not work primarily through official interest rates but through the movements of the balance sheet of the central bank. The Banque de France

[28] On the role of the Bank of France during these two crises, see White (2007) and Hautcoeur, Riva, White (2013).

seemed to be aware of these mechanisms, as shown by the testimony of Governor Pallain (1908) who stressed that high gold reserves were “a compensation” for the stable discount rate and recognized that “gold could be replaced by an equal amount of bills in the portfolio without changing the total of notes in circulation”.

Among the analysts of Banque de France policy, Emanoil (1932) is certainly the one who understood better the link between the Banque de France discount policy and the functioning of the classical gold standard. He wrote:

“The Banque must be in a strong monetary position for its portfolio to increase and its reserves of gold to decrease without causing concern. This is how the Banque could keep low discount rate, at least for a short period of time, in spite of the upward pressure of money market rate. Applied in other countries this policy proved to be far less successful. […]We can see that, even though gold reserves decrease, outstanding notes and Banque’s credit increase. However, this does not mean that gold outflows have no impact on money market rate but that the Banque has more than offset these outflows by increasing its credit operations.”[29] (Emanoil, 1932, p.101 - 104)

4) The official discount-rate and regime changes

Previous sections made clear that the Banque de France was willing to use all possible means to keep a stable and low discount-rate, which in many ways, succeeded. Nevertheless, the Banque discount-rate was sometimes increased or decreased between 1880 and 1914, although rarely. What did motivate these infrequent changes?

If the story we have told so far is right, such increases in the discount rate may be viewed as extreme cases when gold flows and domestic interventions proved to be insufficient to maintain the credibility of the exchange rate band. An analogy would be that an increase in the Banque discount rate was like a devaluation coming after months of defending the parity. This way to think about the discount rate policy of the central bank is very different from the usual way which tends to view the

[29] “ll faut que la Banque d'émission soit dans une situation monétaire très forte pour que son portefeuille puisse augmenter d'une manière sensible et son encaisse diminuer, même sans que cela inspire toutefois beaucoup d'inquiétude. C'est ainsi que la Banque de France a pu garder à différentes reprises, un taux bas et stable, pour un certain temps du moins, malgré la tendance à la hausse du taux de l'escompte. Appliquée à l'étranger ces dernières années, cette même politique a eu beaucoup moins de succès. [...] On peut constater souvent que l'encaisse diminue et que pourtant la circulation fiduciaire et en général les engagements à vue de la Banque d'Emission augmentent. Seulement, cela ne veut pas dire que les sorties d'or n'ont pas pour effet de déterminer une tension du taux de l'argent sur le marché monétaire, mais simplement que la Banque a compensé, et au delà, par les crédits accordés, les sommes retirées du marché, en vue de couvrir les exportations d'or.”

interest rate at the core of international adjustments. It implies that the determination of the discount rate of the central bank is highly nonlinear. In normal times, a rise in the English discount rate and gold outflows would not affect the level of the Banque de France discount rate. In exceptional cases, it would.

Looking at Figure 15 reinforces this conjecture. An increase in the Banque de France discount-rate is always associated with an increase in the English discount-rate and a smaller spread between the interbank rate and the official rate. But, the reverse is not true. Previous studies of the changes in Banque de France discount rates have neglected non linearities in the policy reaction function of the Banque de France. As a consequence, they have found puzzling results, such that the discount rate is neither affected by exchange rate deviations (Gallarotti 1995, Morys 2013), nor by the level of the cover ratio (Tullio and Wolters 2003). Not surprisingly, these studies conclude that standard reaction functions explain little of the variation of the French discount-rate compared to other countries (Gallarotti, 1995, Contamin and Denise 1999). Attempts to consider nonlinearities have led researchers to estimate policy reaction functions with only 35 points (Tullio and Wolters 2003), that is the number of changes of the discount-rate over the period. The finding that the Banque de France did not react to exchange rate deviations or to the level of gold in its vaults is especially doubtful. The central bank was so obsessed by the stability of its discount-rate that it is difficult to consider what reason could have determined the decision to increase the discount rate except gold flowing out and the exchange rate rising. Thus, we need to take into account the nonlinearities in Banque de France decisions. A proper way to do this is to estimate a Markov switching model with two regimes. We expect to obtain a regime where the discount-rate is very likely to remain stable and is not affected by any variable (since the Banque de France defended its stability through gold sales and expansion of domestic credit). In another regime, the Banque de France is expected to change its discount rate under the pressure of international variables and of the changing composition of its balance sheet. This approach is similar to the one used to analyze (Jeanne, Masson 2000) and estimate (Chen 2006) the determinants of devaluations (currency crises) that occur after attempts of central-bank to defend the parity. The interesting issue is to recover the variables that affected or not the Banque de France decision to change its discount rate in each regime.

The estimation endogenously selects two regimes and provides the probabilities of being in either one. The dependent variable is the change in the Banque de France discount rate. The explanatory variables we include in the equation are the spread (between the Paris money market rate and the Banque rate), the Bank of England rate in levels and in variations, the Banque de France gold

stock in levels and in variations, and the deviation from the upper gold point.[30] The latter variable is denoted "Point" and takes small values when the exchange rate approaches the gold export point. The way we conduct the estimation is to try several models in order to obtain the best fit. A good fit is defined such that the change in the Banque de France discount rate is well predicted by the probability to be in one regime.

Figure 24 shows the probability to be in the so-called "regime 2" together with the discount rates of the Bank of England and Banque de France. It is straightforward that the probability of being in "regime 2" equals 1 when the Banque changed its discount rate whereas it is near zero otherwise.

Then, we are interested in how the independent variables explain changes in the Banque rate in each regime. Estimation results are reported in Table 1. In "regime 1", none has a significant effect. This result is not surprising since we have acknowledged that the probability to be in "regime 1" is near 1 when the Banque keeps its discount rate stable. On the contrary, we have selected "regime 2" such that it predicts well the probability that the Banque changes its rate. In this regime, it turns out that the change in the Banque discount rate is significantly affected by all our variables. According to this estimation, the Banque increased its discount rate when the spread is low, when the exchange rate is close to the gold export point, when the Bank rate is high and increasing and when the Banque gold stock is low and decreasing.

The results of the Markov switching model are better understood when we compare it to a standard OLS regression (Table 2). Described previously, the studies that have used this method have obtained non robust and puzzling results. We find the same problem when we run a simple regression with the same variables as in the Markov switching equation. In the specification reported in Table 2, the level of the English Bank rate and the variations of the gold stock have no effect. Similar problems were obtained with different specifications. But the OLS estimation is mis-specified. Results obtained with a switching model show evidence of highly nonlinear relationships. The OLS estimation makes the assumption that an increase in Bank rate would always imply a similar increase in the Banque rate. But the observation of the pattern of the two discount rates has suggested that this assumption does not hold. It is not because of a threshold value of the Bank rate (and such a TAR would also be misspecified). The non-linearity is mainly due to the fact that many factors need to be combined in order to cause an increase in the Banque rate. A rise in the Banque de France rate occurred only in a

[30] We include variables both in levels and variations because we think that the marginal effects matter. A negative change in gold reserves would be probably perceived as unimportant if reserves are high, but very important if reserves are low. Nonetheless, we obtained quite similar results when using only the variables in variations. For the definition of gold points, we use here the values given by Morgenstern (1959) but conclusions are the same when using time-varying gold points following the method of Officer (1996) and Bordo &Macdonald (2005).

very special regime. The main objective of the Banque was to maintain the probability to be in this regime at the lowest possible level.

This section has shown that accounting for nonlinearities is crucial in order to understand that changes in the Banque de France discount rate were indeed significantly determined by the English rate, the exchange rate, the gold stock and the conditions on the French money market. The non-linearity in the decision to change the official discount rate is due to the very nature of the balance sheet policy of the Banque de France.

6) Conclusion

Many studies have characterized the Banque de France as an outlier or as a polar case during the gold standard, but no paper had attempted yet to provide a complete overview of the interventions and methods that allowed the Banque to continuously violate the rules of the game while staying credible and maintaining the parity. This paper attempts to fill this gap and argues that the answer lies in the balance sheet of the central bank. The main objective of the Banque was to keep a stable discount rate. In order to achieve this objective, the Banque used the gold stock (i.e sold it when foreign rates increased), used gold devices and foreign interventions (although moderately and non-continuously over the period) and, most of all, used its discount portfolio to fulfill the demand of French banks and, then, avoid excessive deviations in the spread between the interbank rate and the official discount rate of the central bank. Gold sales and purchases affected international rates whereas discounting was used to absorb international shocks and control the domestic interest rate. As such, the Banque de France discount rate was largely disconnected from the English rate. Only in extreme cases, the Banque had to follow the Bank of England. We have shown that such decisions were determined by the standard forces of the gold standard (exchange-rate deviations, interest rates differentials, cover ratio etc.). The policy of the Banque de France should be interpreted as the product of a dual constraint (or a double objective): maintaining the stability of the domestic discount-rate and maintaining the fixed parity of the exchange-rate. The balance sheet was used to achieve both objectives. When necessary, in few extreme cases, the Banque always preferred to change the discount rate rather than modifying the exchange rate parity. But these increases in the discount-rate were seldom and temporary. Frequent or permanent deviations from the implicit discount rate target of 2-3% would have threatened the domestic legitimacy of the exchange-rate regimes, in the same way that a permanent suspension of convertibility would have threatened the international credibility of France abroad. As a consequence, the ability of the Banque de France to use its balance sheet to absorb international shocks is probably a

key element to explain - in political economy terms - the long lasting adherence of the country to the gold standard.[31]

Indeed, the Banque de France was at the extreme of the spectrum; the Bank of England being at the other one. But it was not an outlier. Several central banks fell in between, with values of the cover ratio or reserves and number of interest rate changes being closer to France than to England (Morys 2013). Our study of France under the gold standard tends to bring at least three conclusions that could not be drawn from the English case and that are useful for the study of other countries: international adjustments could work through the balance sheets of central-banks rather than through interest rates (and the former is thus more important to look at than the latter), the objective of a stable discount-rate forced the central bank to be able to change rapidly and dramatically the composition of the balance sheet, and finally, the setting of the official discount rate was highly nonlinear. A more general conclusion of this study is that the main forces of the gold standard were at work despite constant violations of the rules of the game: the central bank kept a close eye on exchange-rate deviations; exchange-rates adjusted through gold movements. Notwithstanding very different central banking practices, domestic objectives and interpretations of the so-called “rules of the game”, the gold standard still worked as a credible rule.

[31] Foreign exchange interventions were another usual tool – in addition to gold devices – which was mainly used by small central banks to stabilize the exchange rate and isolate partly domestic economies from international shocks (Reis 2007, Esteves et al. 2009, Jobst 2009, Ugolini 2012). The objective and operations of the Banque de France were different in kind and in quantity.

APPENDIX

Data sources

N.B: all data are monthly except railway revenues which are quarterly

- Imports and exports

  From 1880-1885: Statistiques mensuelles du commerce extérieur de la France (Direction générale des douanes et droits indirects).

  From 1886 to 1914 : Bulletin de statistique et législation comparée (available in NBER MacroHistory database, series m07027 and m07032)

- Excess specie imports

  White (1933)

- Banque de France discount rate

  NBER MacroHistory database, series m13014

- Bank of England discount rate

  NBER MacroHistory database, series m13013

- Reichsbank discount rate

  NBER MacroHistory database, series m13015

- Money market rate in Paris

  The Economist, available in NBER MacroHistory database, series m13017

- Money market rate in London (open market of discounts)

  NBER MacroHistory database, series m13016

- Exchange rate Paris-London

  NBER MacroHistory database, series m14107

- Exchange rate Paris – Berlin

  NBER MacroHistory database, series m14071

- Foreign portfolio

  ANNHIS

- Gold premium in Paris

  White (1933)

- French 6-month interest rate on government bonds

  Pierre Arbulu, "Le marché parisien des actions au XIXè siècle" in "Le marché financier français au XIXè siècle", Vol II, Paris, Les Publications de la Sorbonne, 2006.

- Gold and silver reserves of the Banque de France

  ABF, Situation hebdomadaire de la Banque de France
  (available online from 1898 :
  http://www.banque-france.fr/la-banque-de-france/histoire/annuaire-historique.html)

- Advances and discounts of the Banque de France

  ABF, Situation hebdomadaire de la Banque de France
  (available online from 1898 :
  http://www.banque-france.fr/la-banque-de-france/histoire/annuaire-historique.html)

- Notes in circulation

  White (1933)

- Stock market index

  David Le Bris, *Les actions françaises depuis 1854 : analyses et découvertes*, Phd Dissertation, Université d'Orléans, 2011. This an index of the forty largest firms listed in the official stock market. Cf also Le Bris and Hautcoeur (2010) for further details on the dataset.

- Monthly price index (1900-1913)

  La *Réforme économique* (20 commodities).

- Railway revenues

  Revenues of the companies of the General network (“réseau d’intérêt general”) which was divided in 7 large networks (“Paris-Lyon-Méditerranée ; Rhône au Mont-Cenis ; Nord ; Ouest ; Orléans ; Est ; Midi”). Reported revenues of the companies are from passengers and freight, not from other sources (state subsidies, financial investments etc.).

  From 1880 à 1886, Bulletin du Ministère des travaux publics. Statistics are available for each network. We add the revenues of the 7 networks. Data are quarterly.

  From 1887 à 1899 ; Bulletin de statistique et législation comparée. Data are quarterly. The Bulletin publishes the sum of the revenues of the 7 networks.

From 1900 à 1913 ; Bulletin de statistique et législation comparée. Data are monthly; we sum the revenues for each quarter. The Bulletin publishes the sum of the revenues of the 7 networks.

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Figure 1 : Discount rates of the Banque de France, the Bank of England and the Reichsbank, 1880-1914.

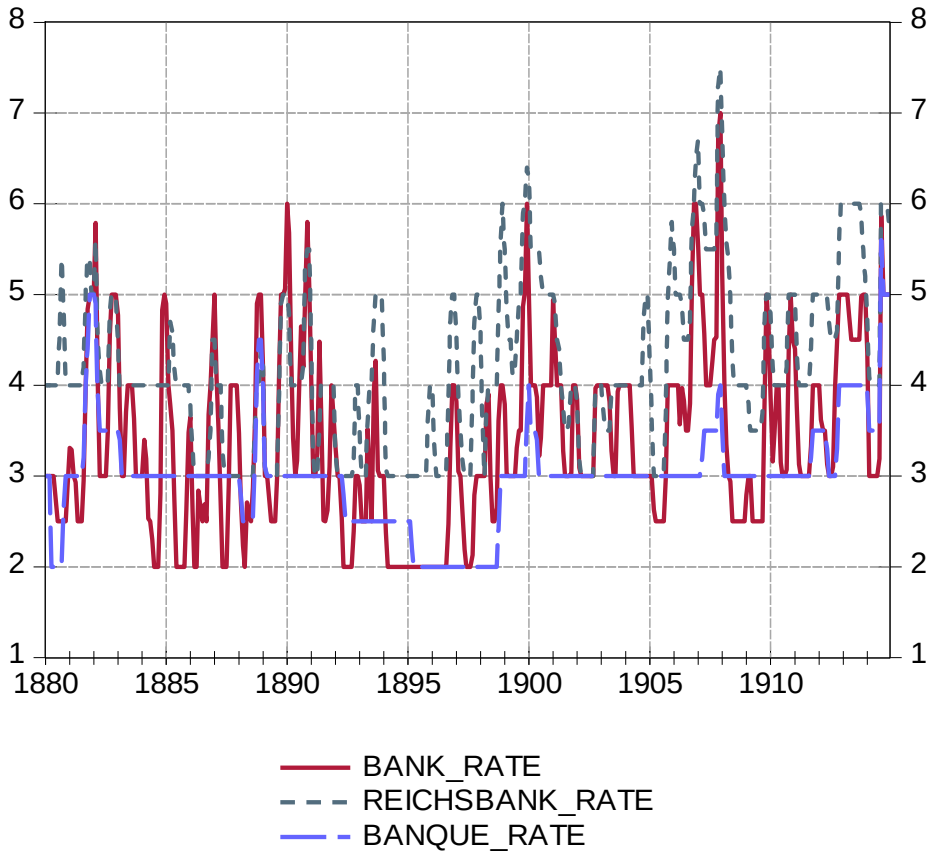


Figure 2 : Gold premium at Paris (per 1000 francs) and Bank of England discount rate, 1880-1914.

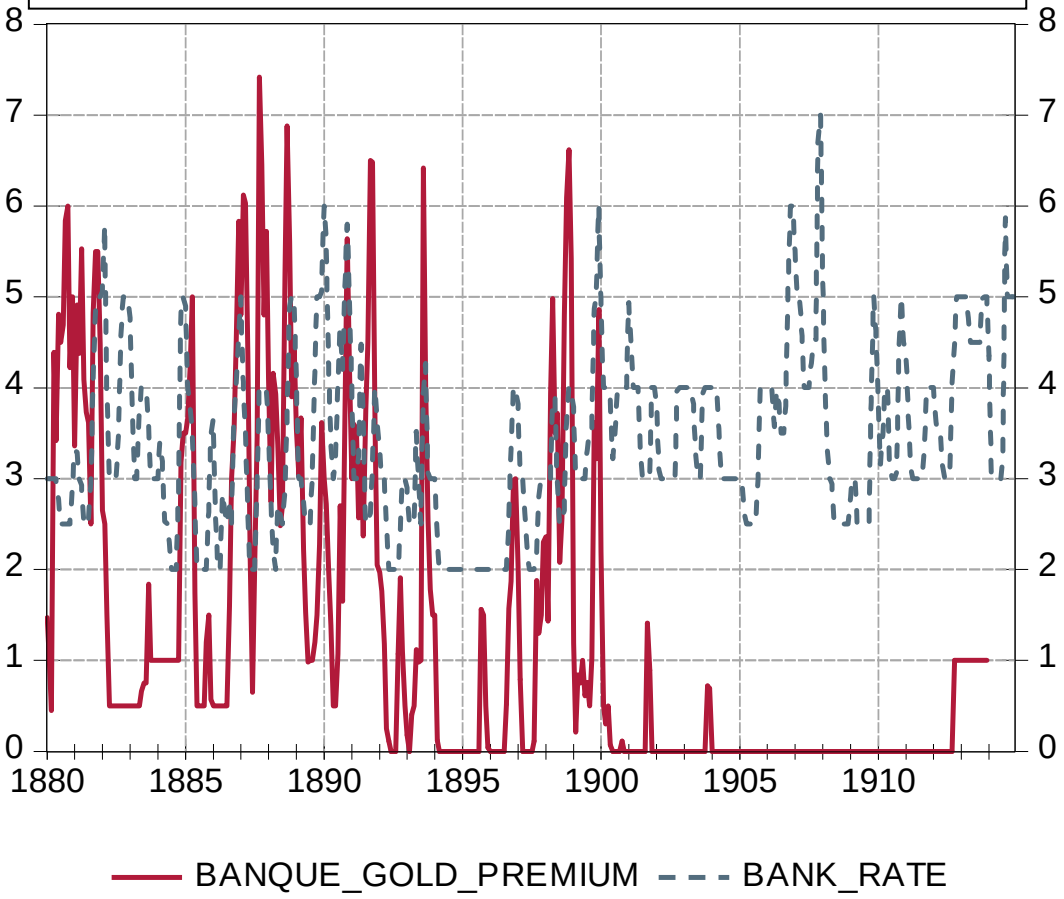


Figure 3

Responses to One S.D. Innovation on the Bank of England rate
Cholesky decomposition. Bank rate ordered first.
± 2 S.E.

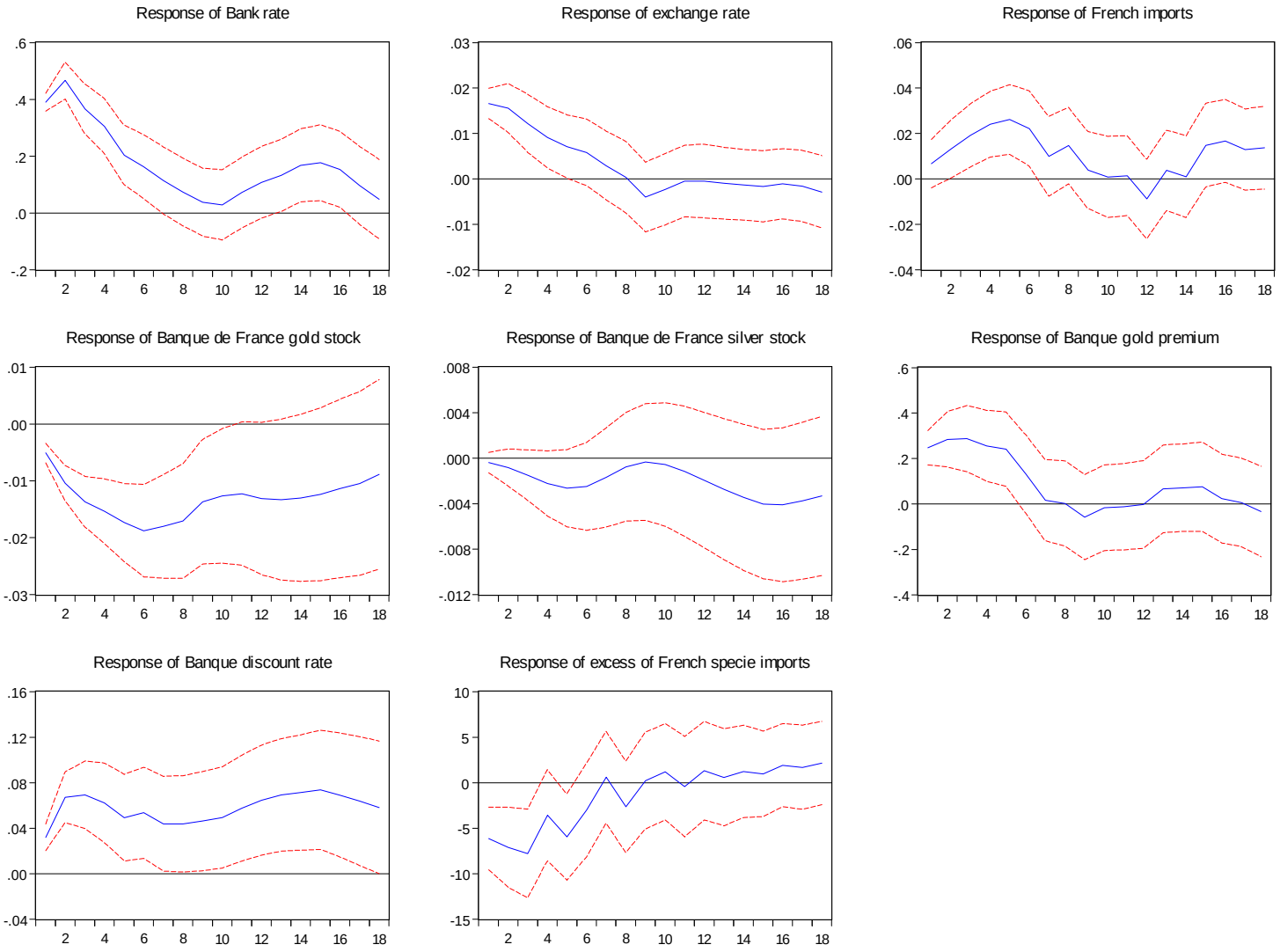


Figure 4

Response to Cholesky One S.D. Innovations ± 2 S.E.

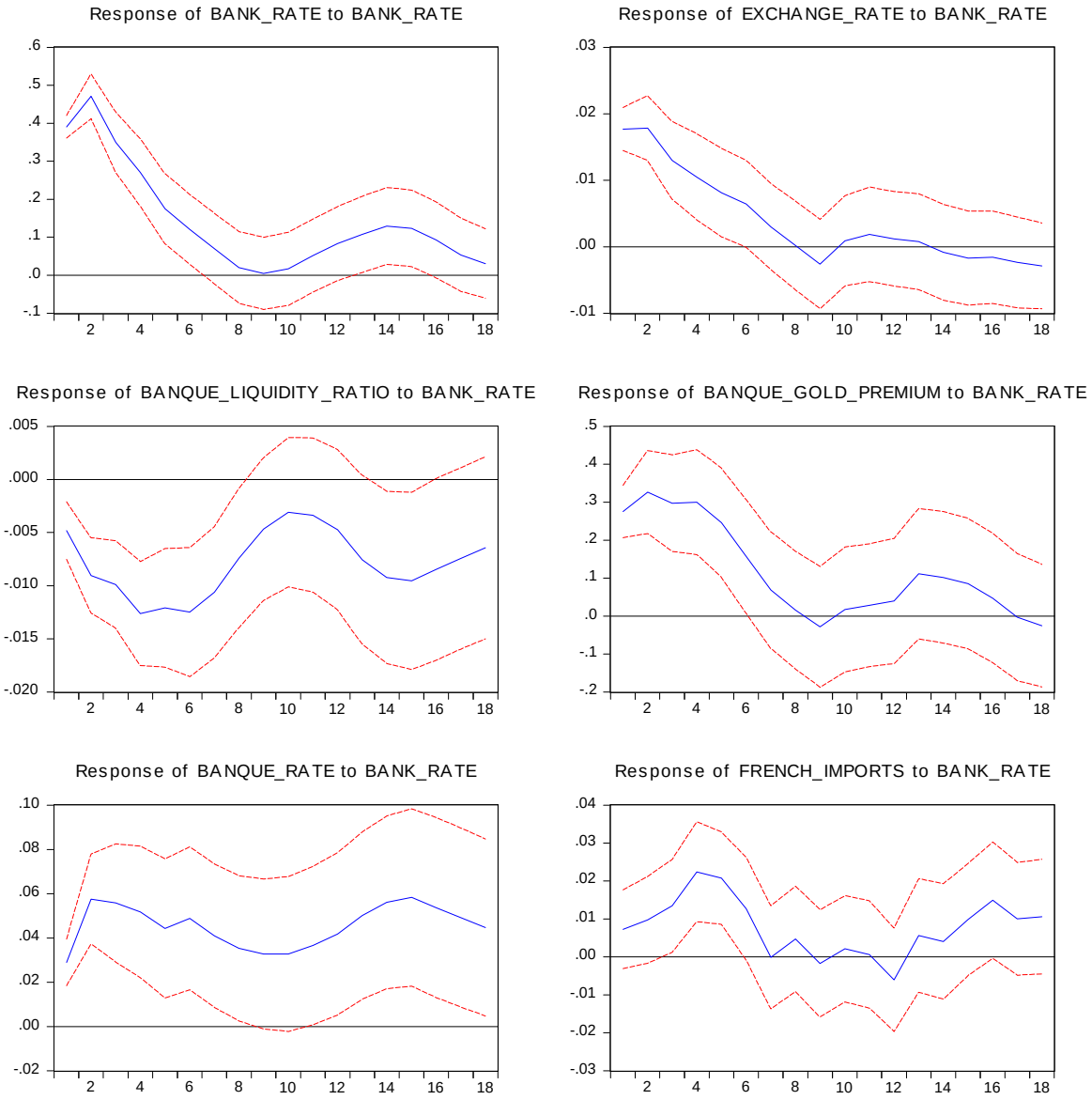


Figure 5: gold and silver stock of the Banque de France (1880-1914)
(stock in Ff. 1,000)

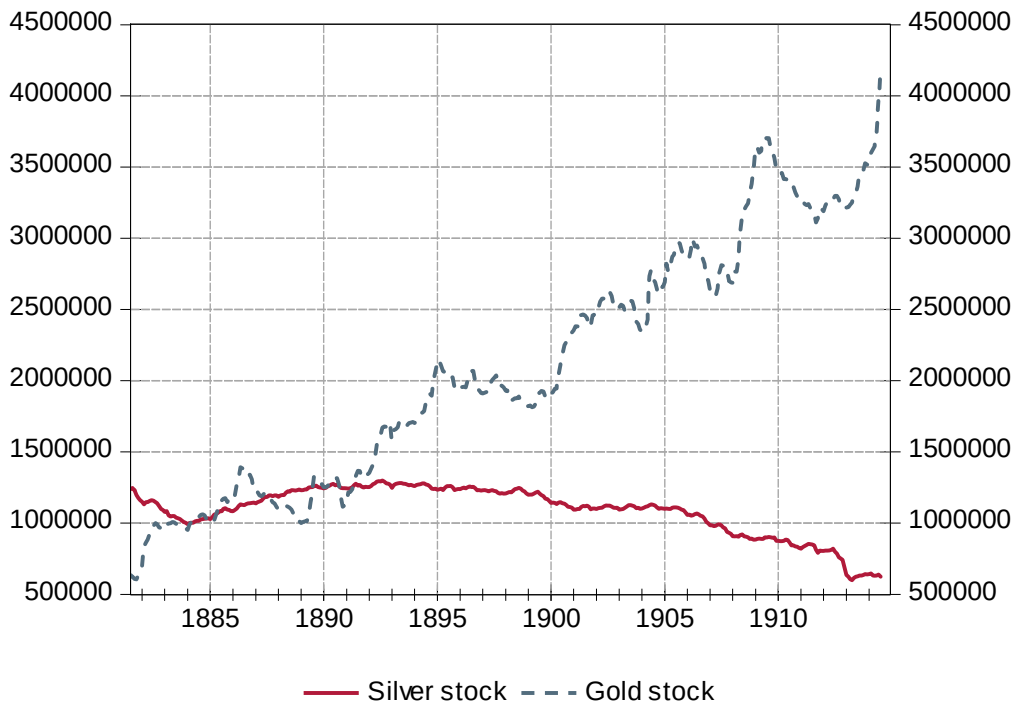


Figure 6: Liquidity ratio the Banque de France

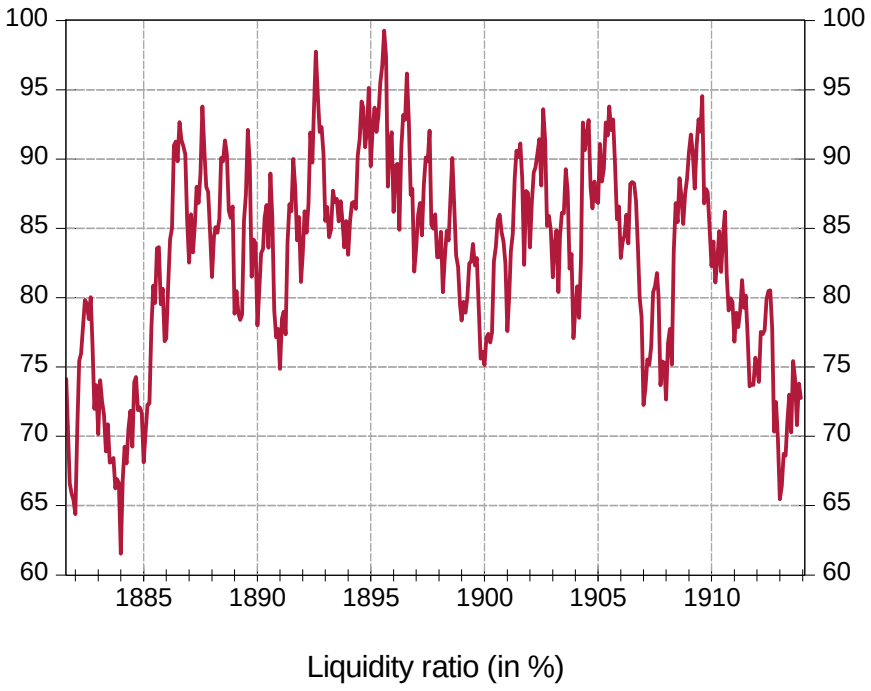


Figure 7

Response to Cholesky One S.D. Innovations ± 2 S.E.
First part of the sample: 1880-1900

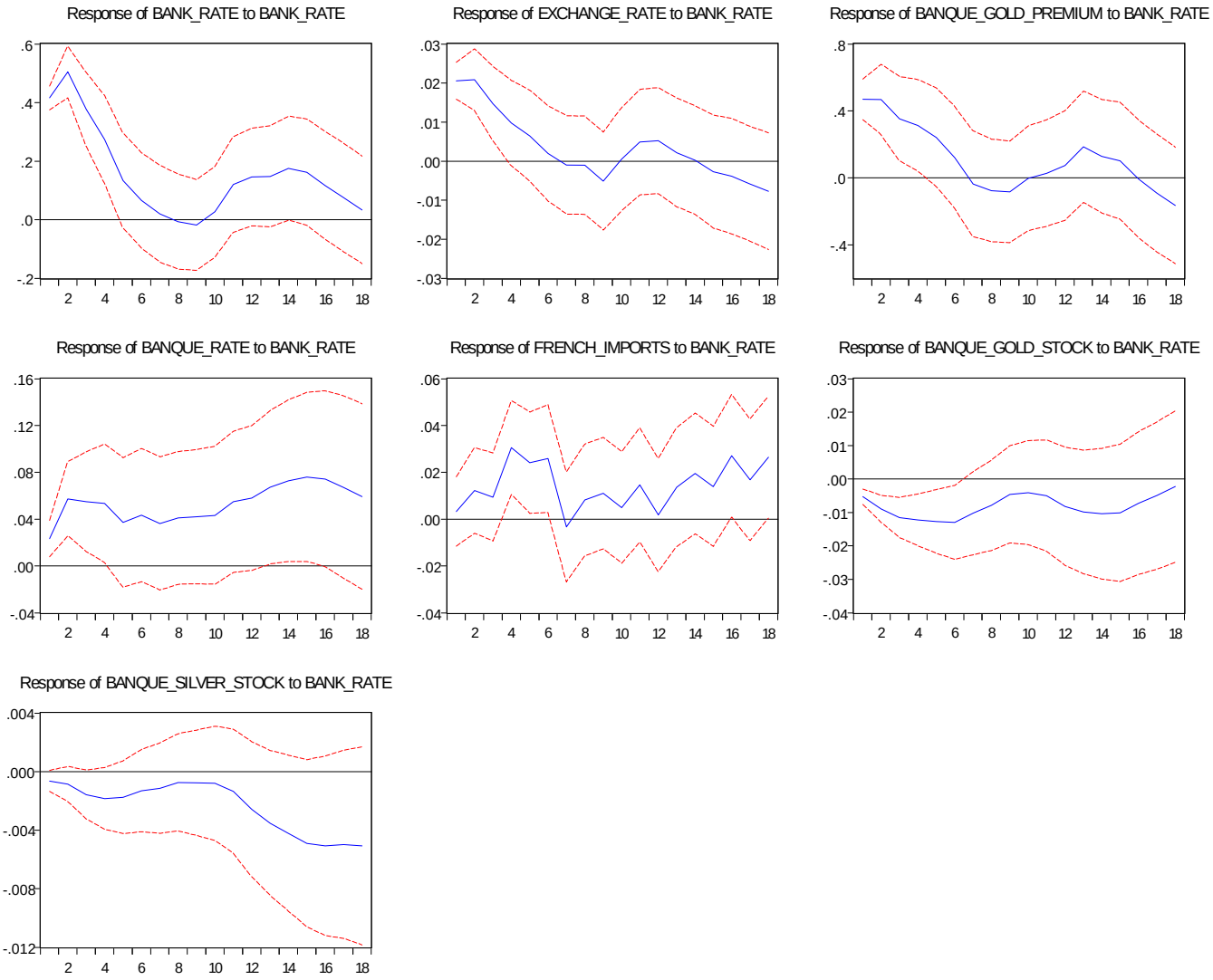
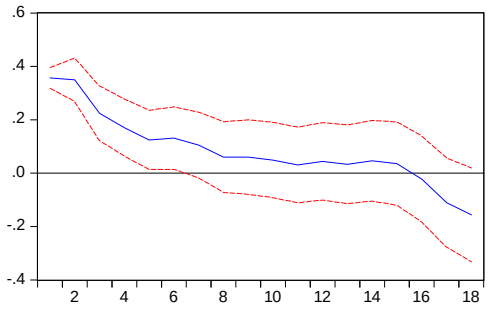


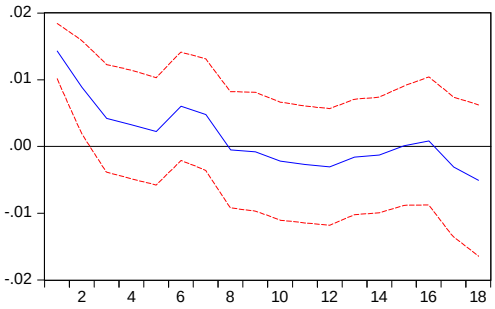
Figure 8

Response to Cholesky One S.D. Innovations ± 2 S.E.
Second par of the sample, 1900-1914

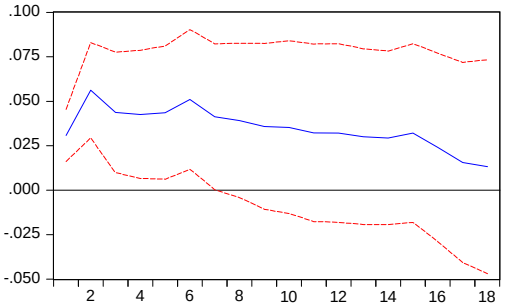
Response of BANK_RATE to BANK_RATE



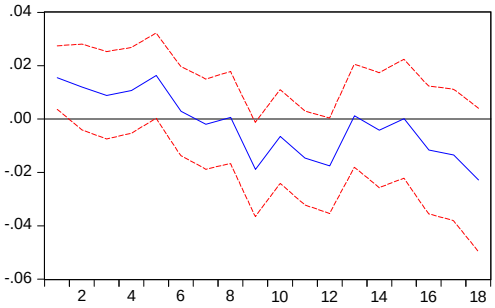
Response of EXCHANGE_RATE to BANK_RATE



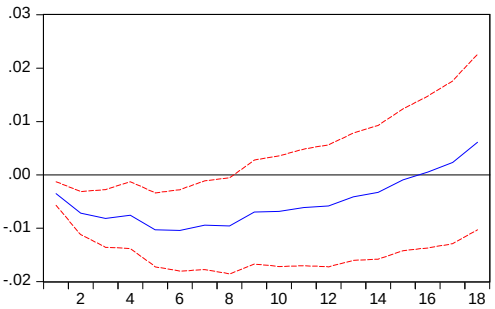
Response of BANQUE_RATE to BANK_RATE



Response of FRENCH_IMPORTS to BANK_RATE



Response of BANQUE_GOLD_STOCK to BANK_RATE



Response of BANQUE_SILVER_STOCK to BANK_RATE

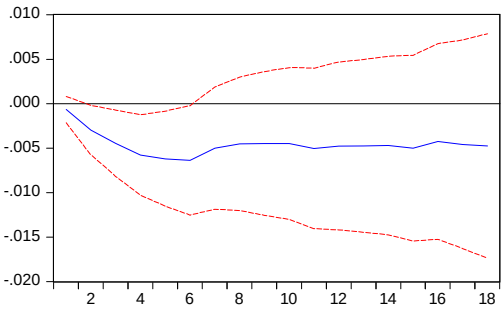
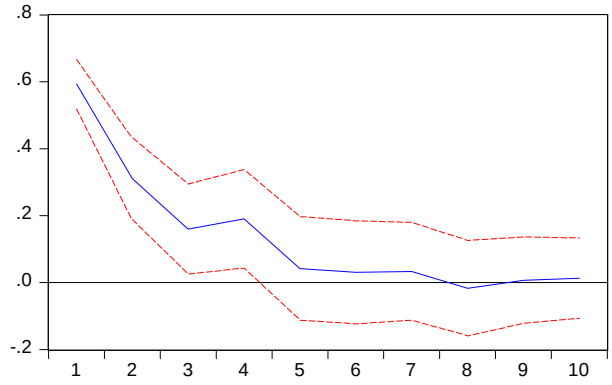


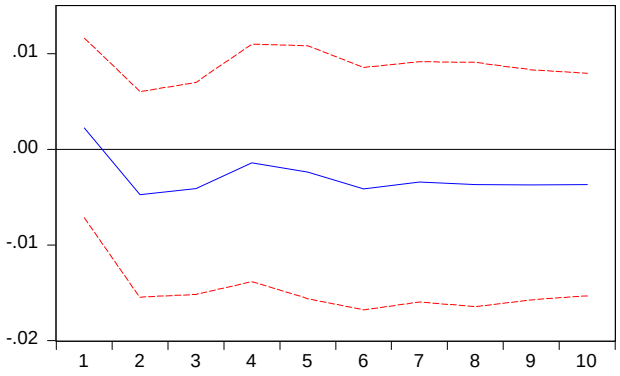
Figure 9

Response to Cholesky One S.D. Innovations ± 2 S.E.

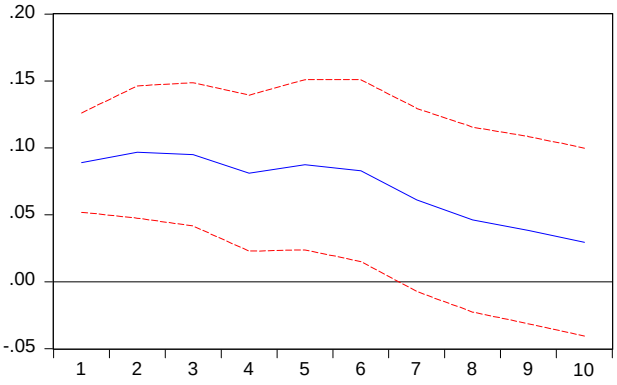
Response of BANK_RATE to BANK_RATE



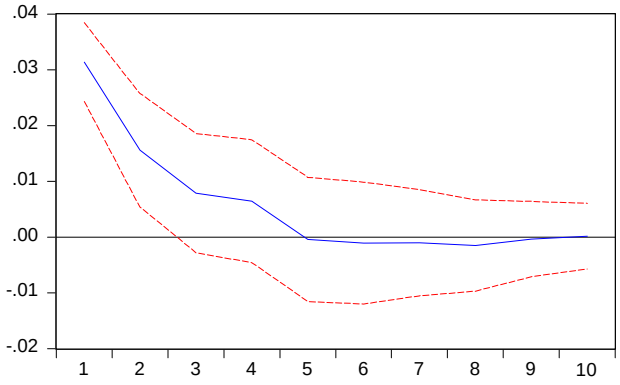
Response of RAILWAYS INDEX to BANK_RATE



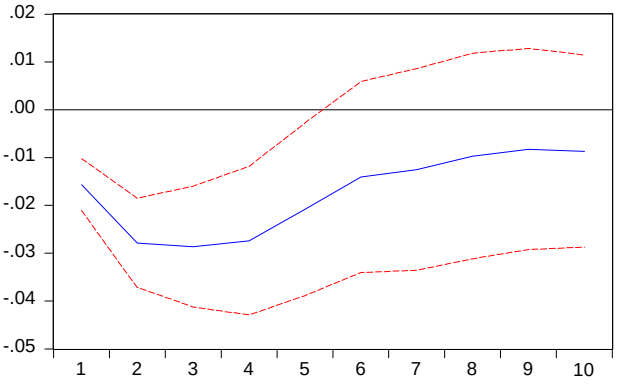
Response of BANQUE_RATE to BANK_RATE



Response of EXCHANGE_RATE to BANK_RATE



Response of BANQUE_GOLD_STOCK to BANK_RATE



Response of BANQUE_GOLD_PREMIUM to BANK_RATE

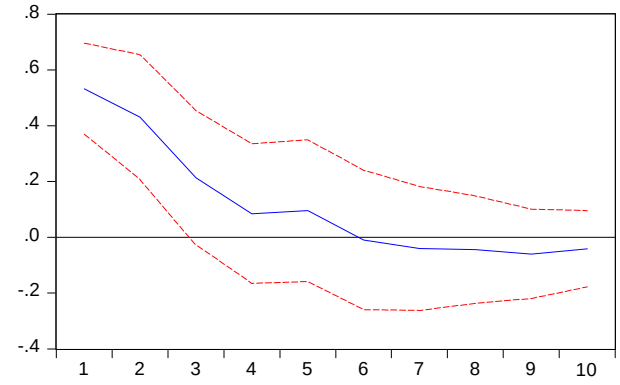
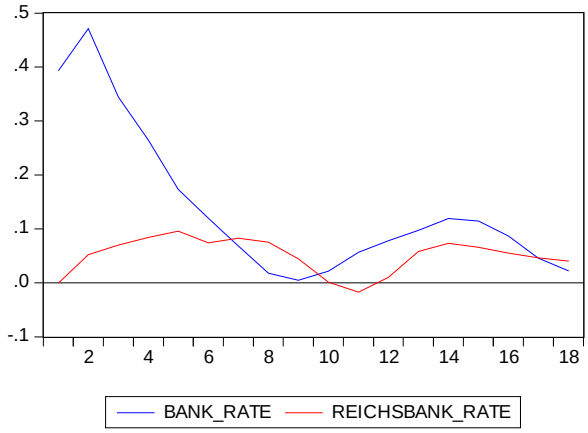


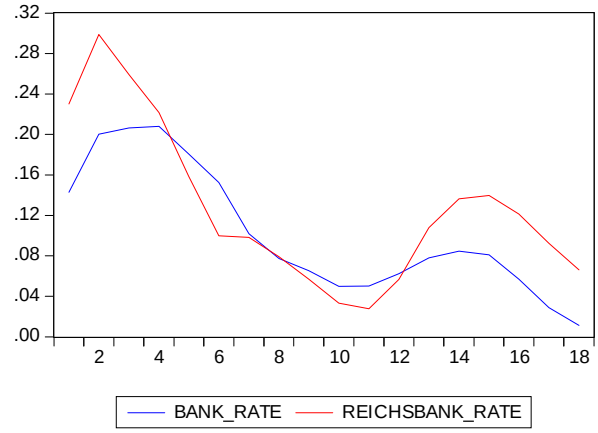
Figure 10

Comparisons of Responses to shocks on Bank rate and Reichsbank rate.
Cholesky decomposition.
Bank rate ordered first.

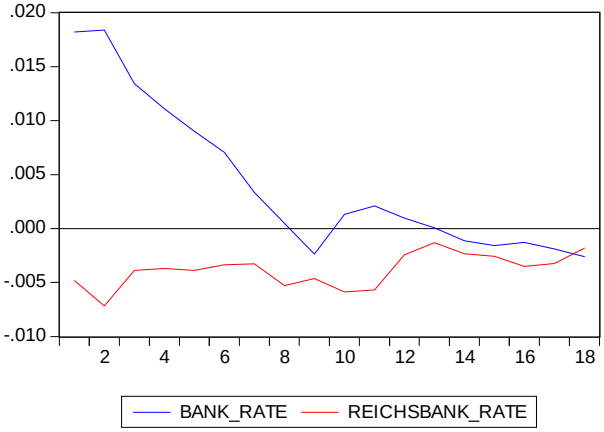
Response of BANK_RATE to Cholesky
One S.D. Innovations



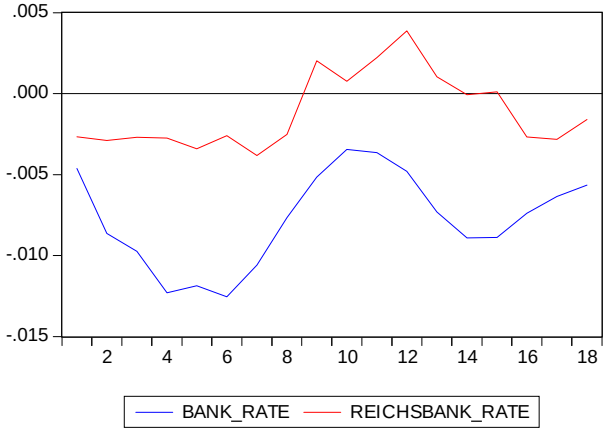
Response of REICHSBANK_RATE to Cholesky
One S.D. Innovations



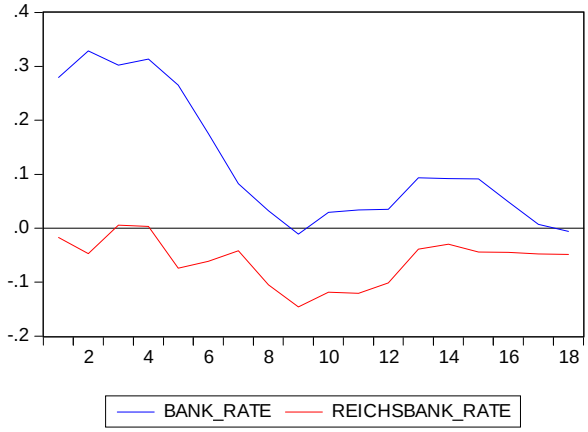
Response of EXCHANGE_RATE to Cholesky
One S.D. Innovations



Response of BANQUE_LIQUIDITY_RATIO to Cholesky
One S.D. Innovations



Response of BANQUE_GOLD_PREMIUM to Cholesky
One S.D. Innovations



Response of BANQUE_RATE to Cholesky
One S.D. Innovations

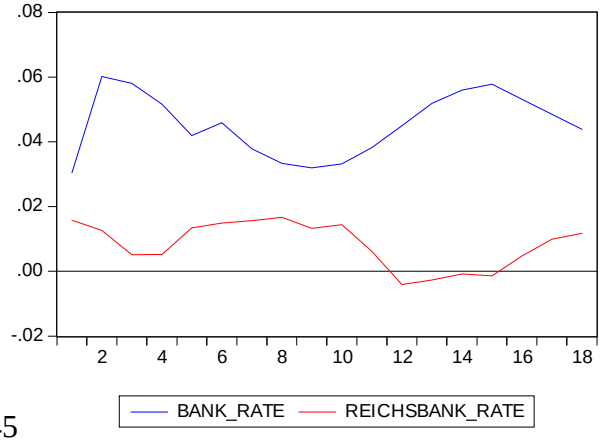
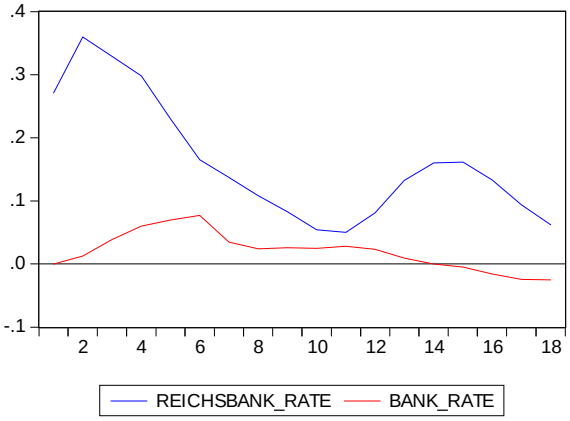


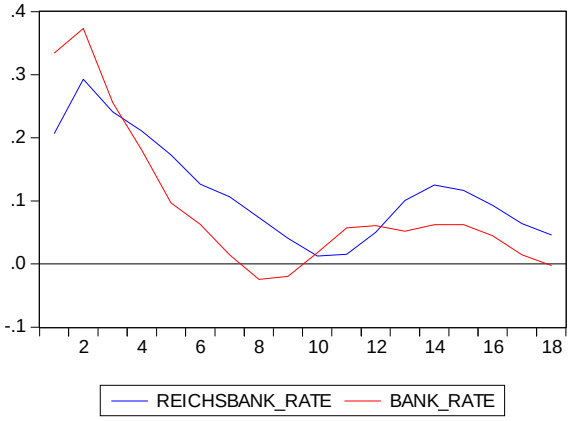
Figure 11

Comparisons of Responses to shocks on Bank rate and Reichsbank rate.
Cholesky decomposition.
Reichsbank rate ordered first.

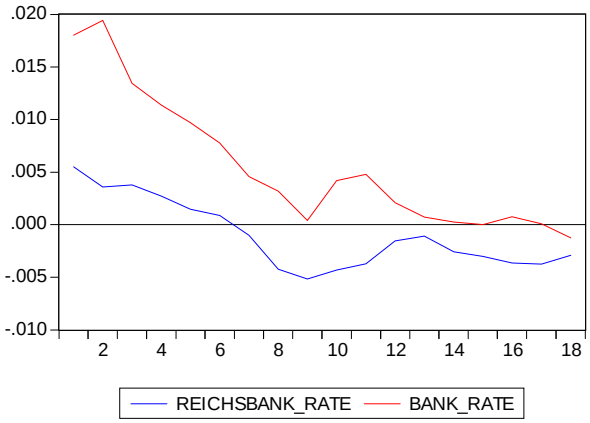
Response of REICHSBANK_RATE to Cholesky
One S.D. Innovations



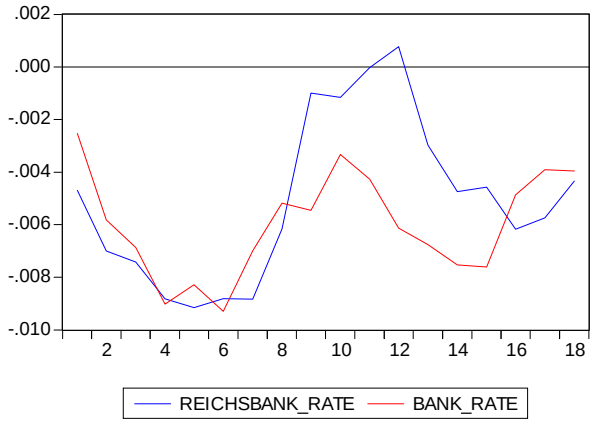
Response of BANK_RATE to Cholesky
One S.D. Innovations



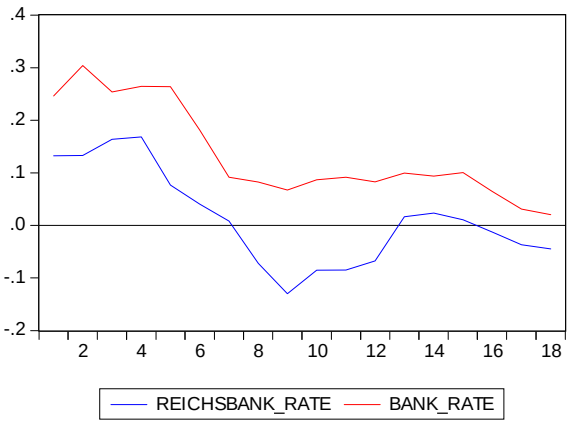
Response of EXCHANGE_RATE to Cholesky
One S.D. Innovations



Response of BANQUE_LIQUIDITY_RATIO to Cholesky
One S.D. Innovations



Response of BANQUE_GOLD_PREMIUM to Cholesky
One S.D. Innovations



Response of BANQUE_RATE to Cholesky
One S.D. Innovations

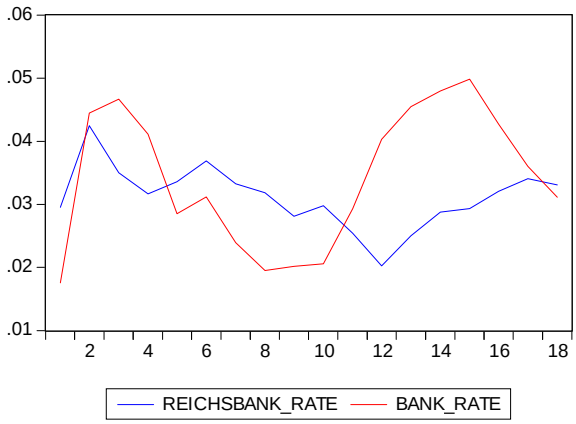


Figure 12 :Banque de France's foreign portfolios and discount rate and Bank of England discount rate

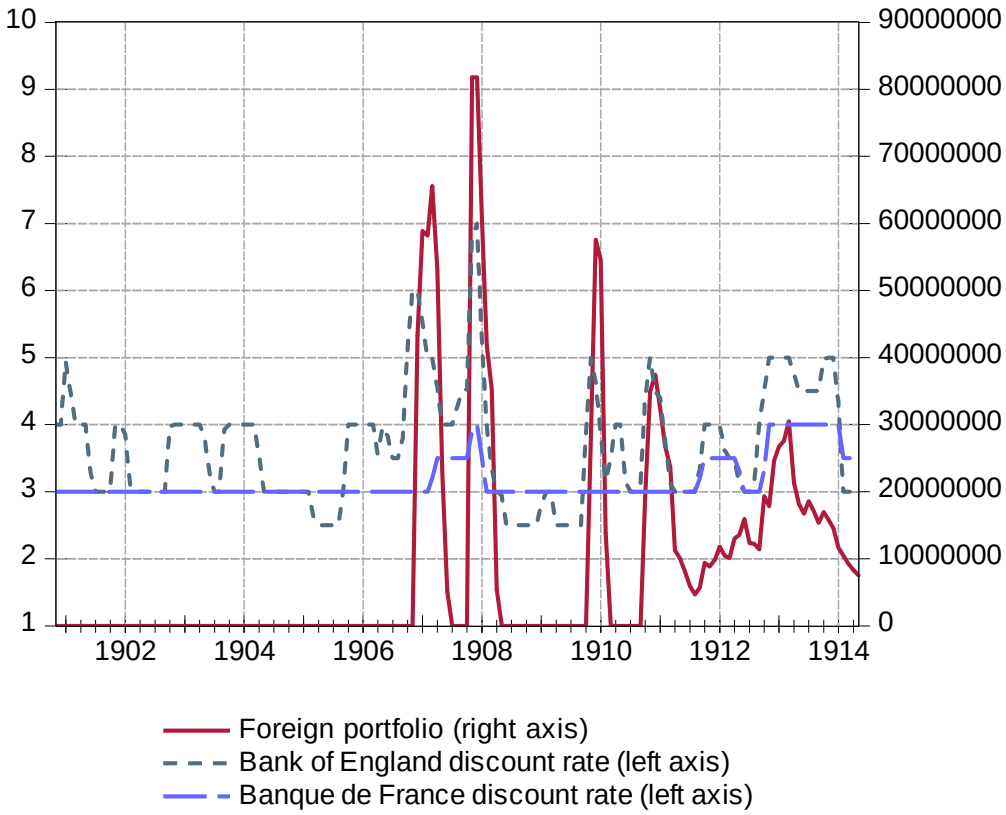
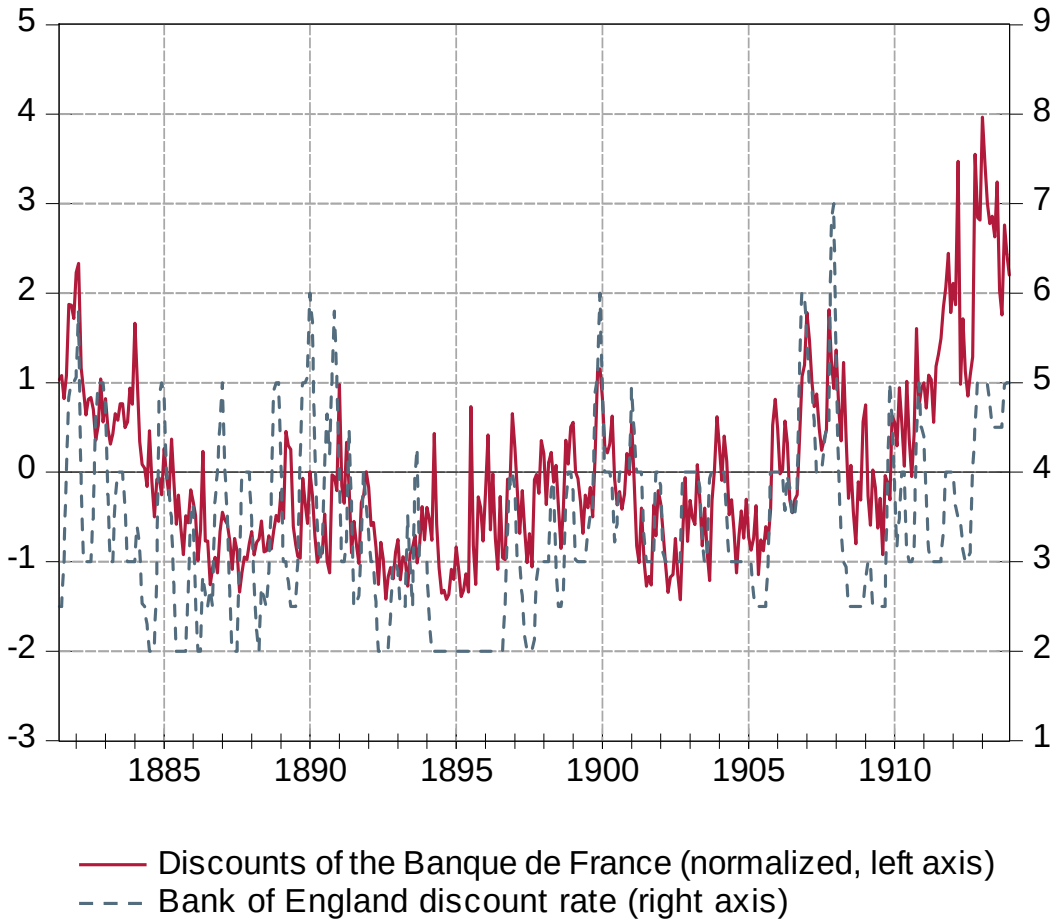


Figure 13: Banque de France domestic portfolio and Bank of England discount rate



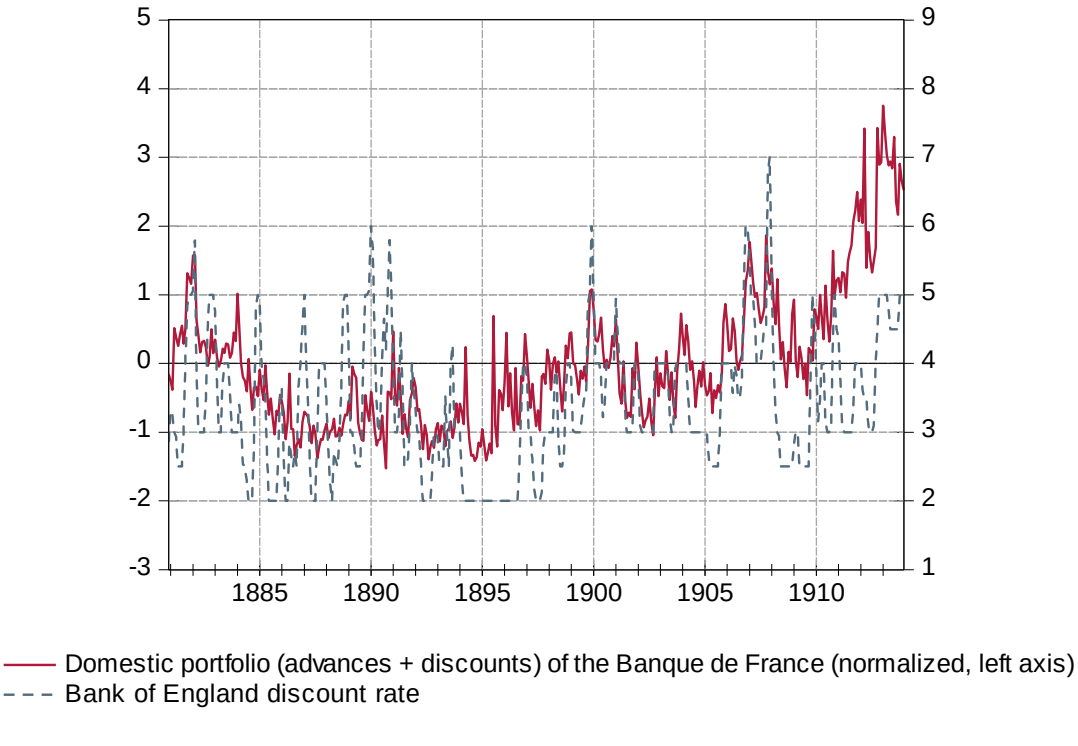

5
4
3
2
1
0
-1
-2
-3
9
8
7
6
5
4
3
2
1
1885
1890
1895
1900
1905
1910
Domestic portfolio (advances + discounts) of the Banque de France (normalized, left axis)
Bank of England discount rate

Figure 14: Negative co-movement between metallic reserves and domestics assets

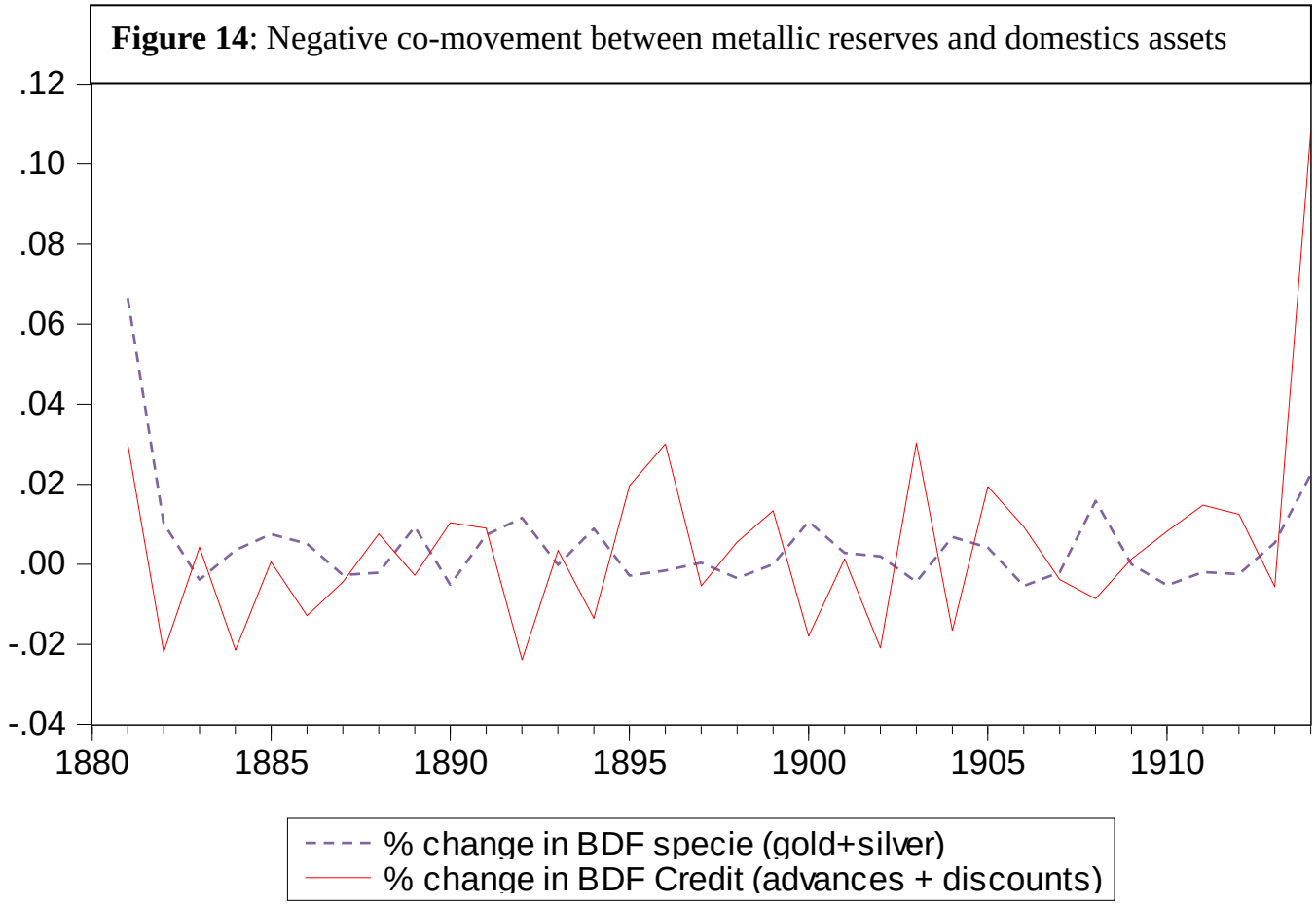


Figure 15: The money market rate

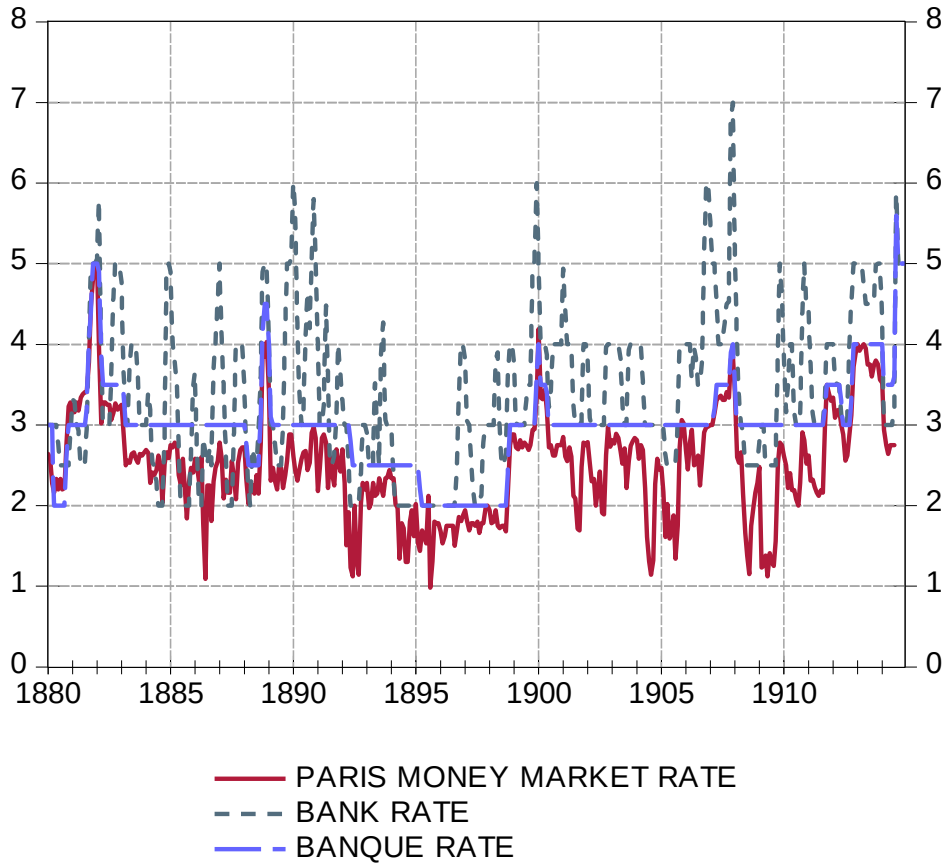
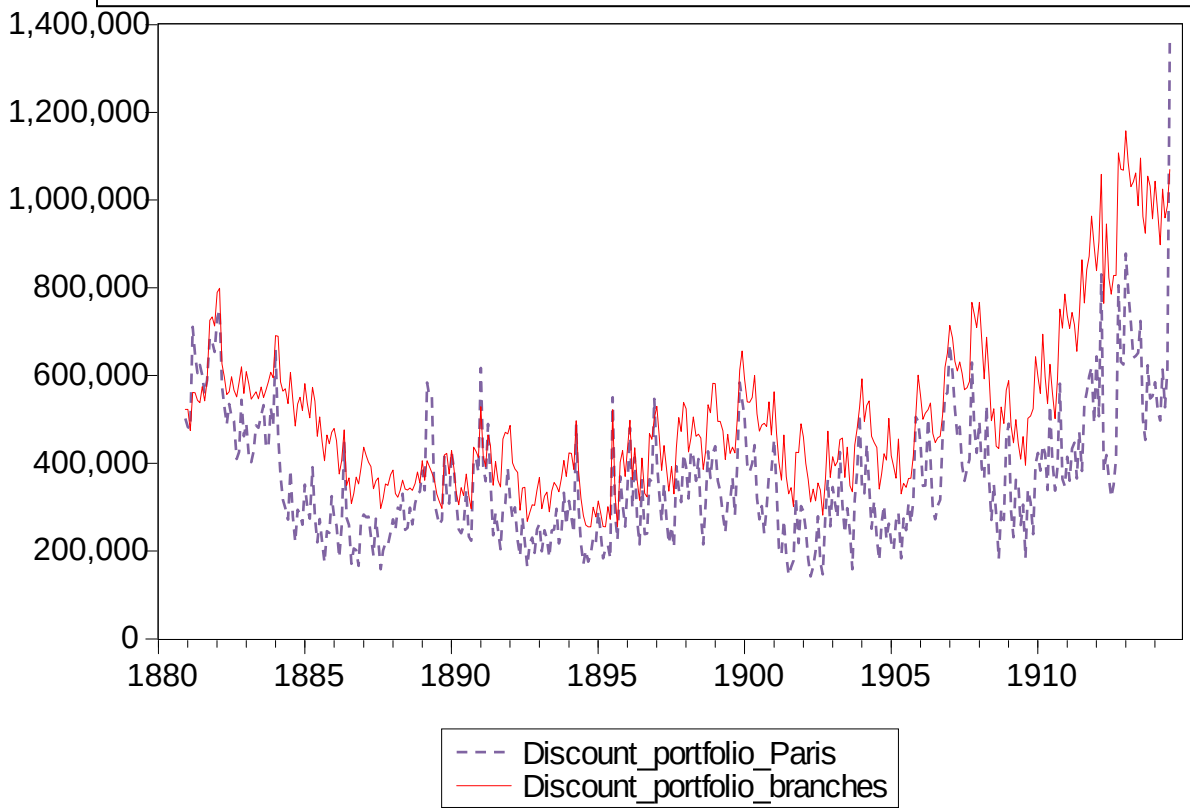
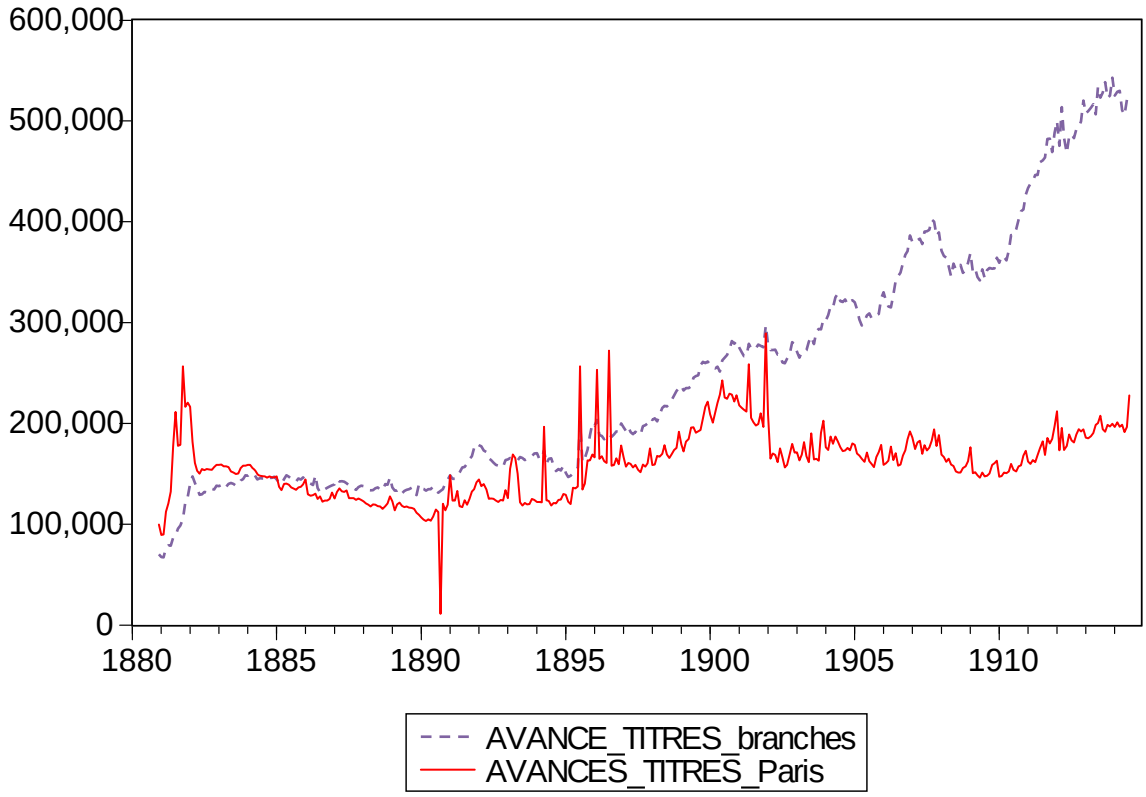


Figure 16: Banque de France balance sheet





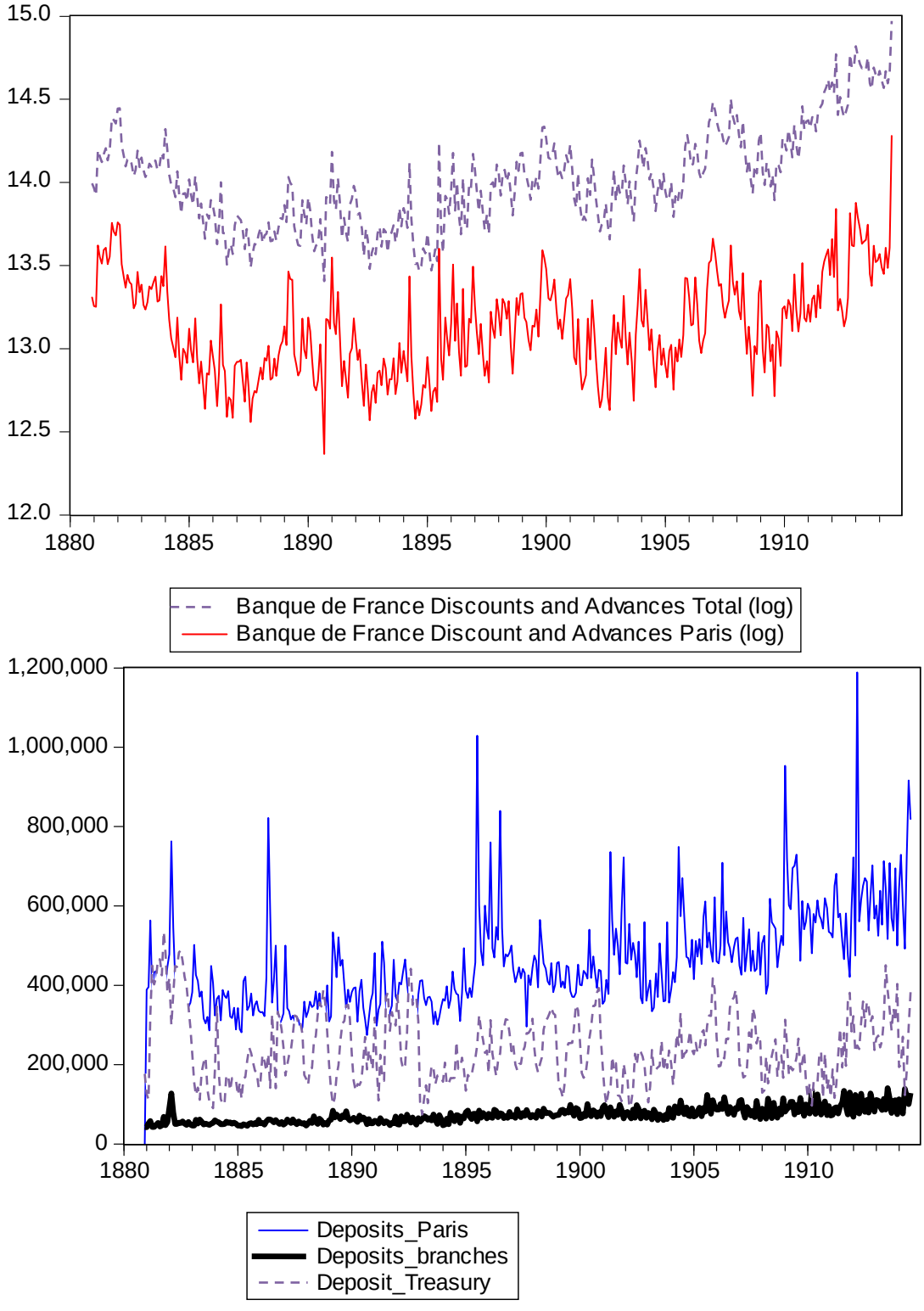

15.0
14.5
14.0
13.5
13.0
12.5
12.0
1880
1885
1890
1895
1900
1905
1910
Banque de France Discounts and Advances Total (log)
Banque de France Discount and Advances Paris (log)
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
1880
1885
1890
1895
1900
1905
1910
Deposits_Paris
Deposits_branches
Deposit_Treasury

Figure 17

Response to Cholesky One S.D. Innovations ± 2 S.E.

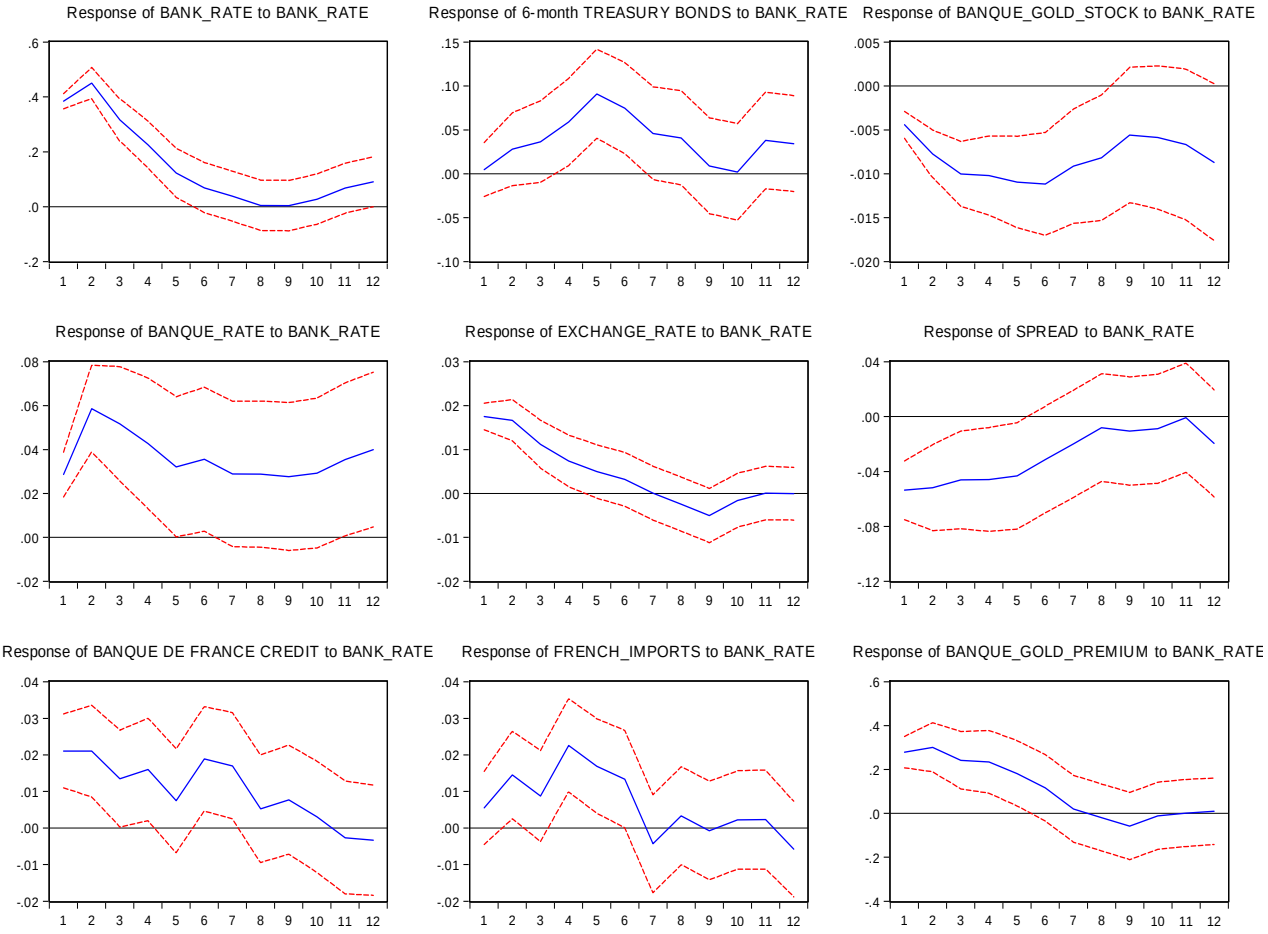
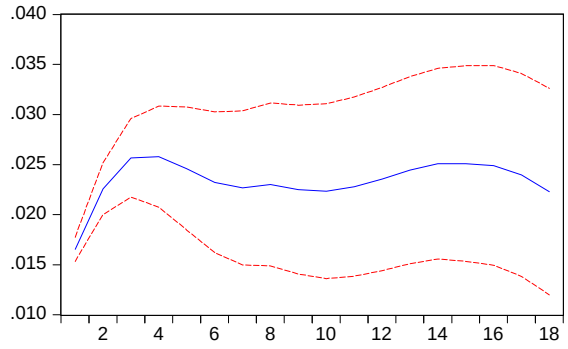


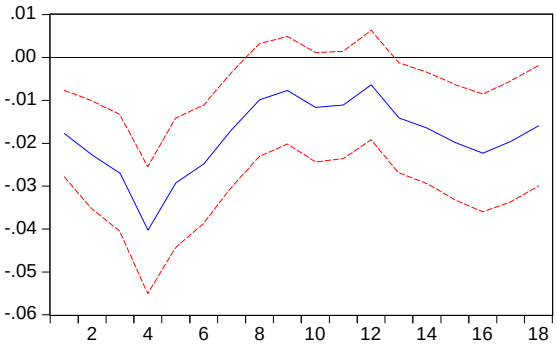
Figure 18

Response to Cholesky One S.D. Innovations ± 2 S.E.

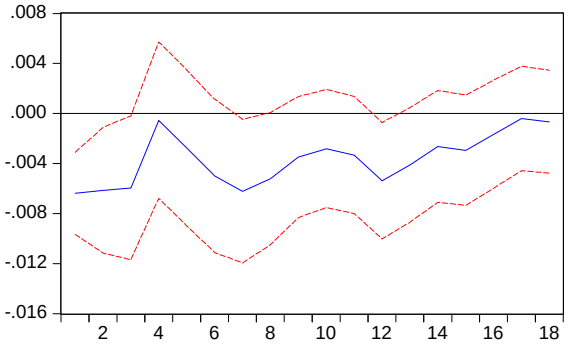
Response of BANQUE_GOLD_STOCK to BANQUE_GOLD_STOCK



Response of BDF_CREDIT to BANQUE_GOLD_STOCK



Response of EXCHANGE_RATE to BANQUE_GOLD_STOCK



Response of SPREAD to BANQUE_GOLD_STOCK

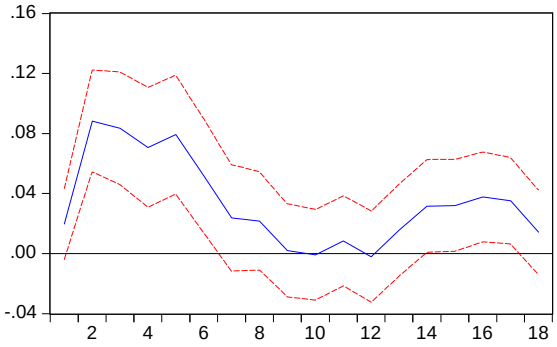


Figure 19

Response to Cholesky One S.D. Innovations ± 2 S.E.

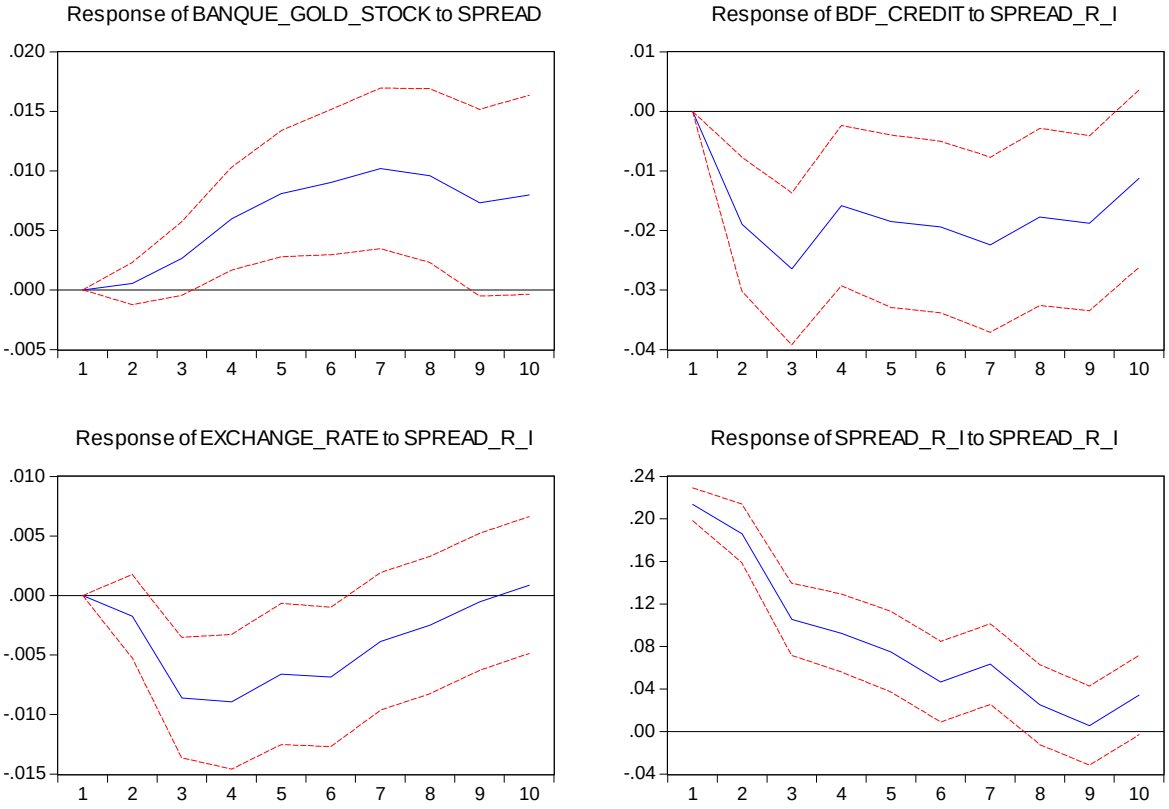
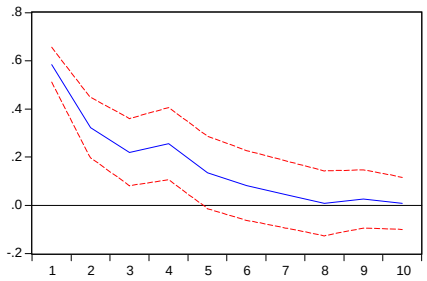


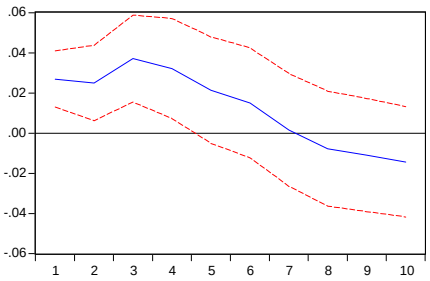
Figure 20

Response to Cholesky One S.D. Innovations ± 2 S.E.
Quarterly data.

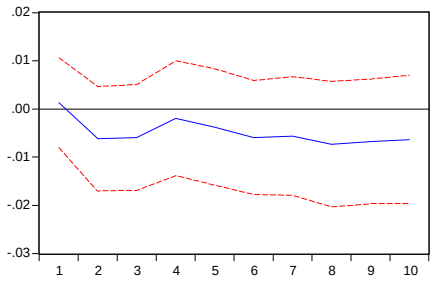
Response of BANK_RATE to BANK_RATE



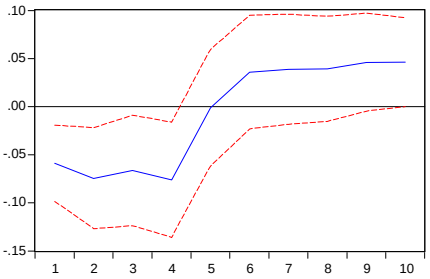
Response of BDF_CREDIT to BANK_RATE



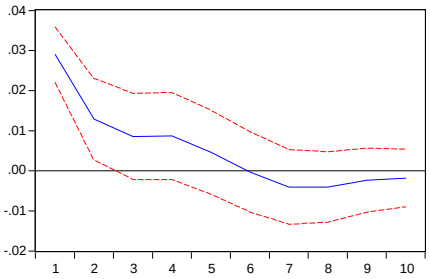
Response of RAILWAYS INDEX to BANK_RATE



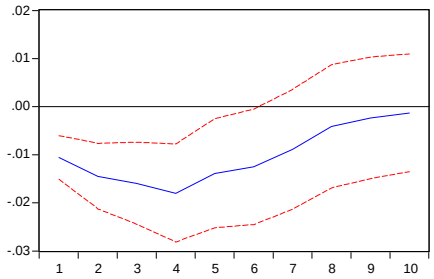
Response of SPREAD to BANK_RATE



Response of EXCHANGE_RATE to BANK_RATE



Response of BANQUE_LIQUIDITY_RATIO to BANK_RATE



Response of BANQUE_GOLD_PREMIUM to BANK_RATE

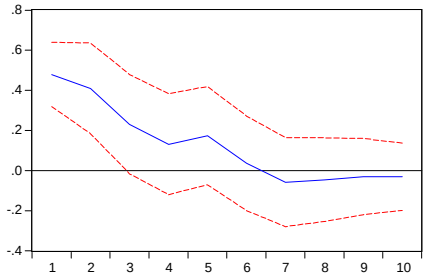
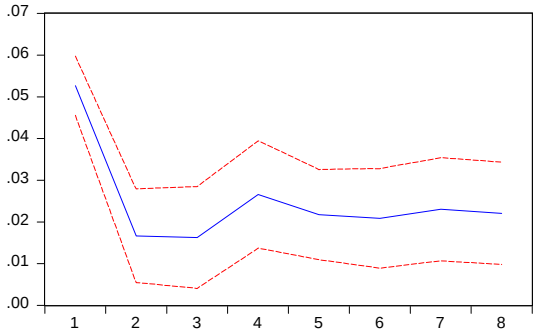


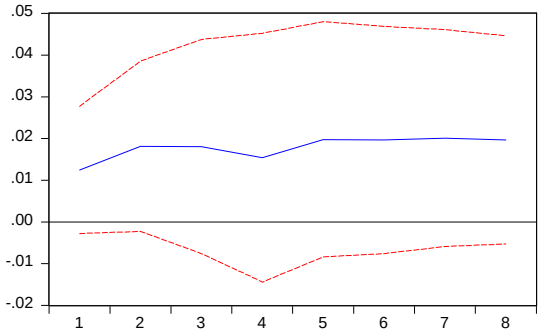
Figure 21

Response to Cholesky One S.D. Innovations ± 2 S.E.

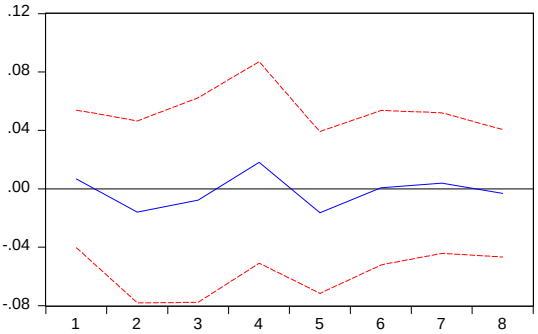
Response of RAILWAYS to RAILWAYS



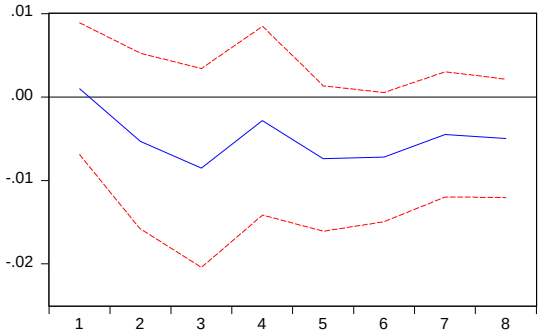
Response of BDF_CREDIT to RAILWAYS



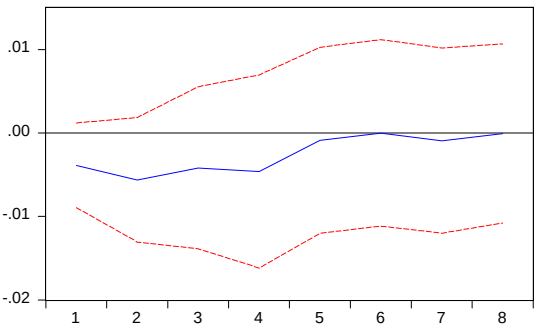
Response of SPREAD_R_I to RAILWAYS



Response of EXCHANGE_RATE to RAILWAYS



Response of BANQUE_LIQUIDITY_RATIO to RAILWAYS



Response of FRENCH_IMPORTS to RAILWAYS

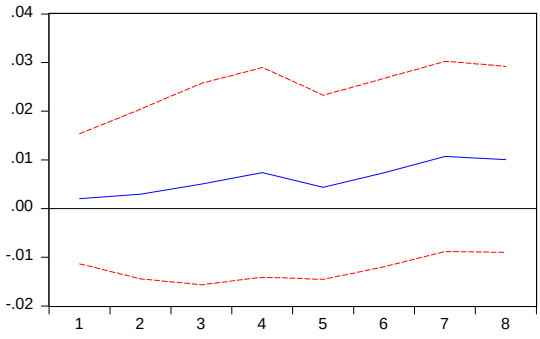


Figure 22

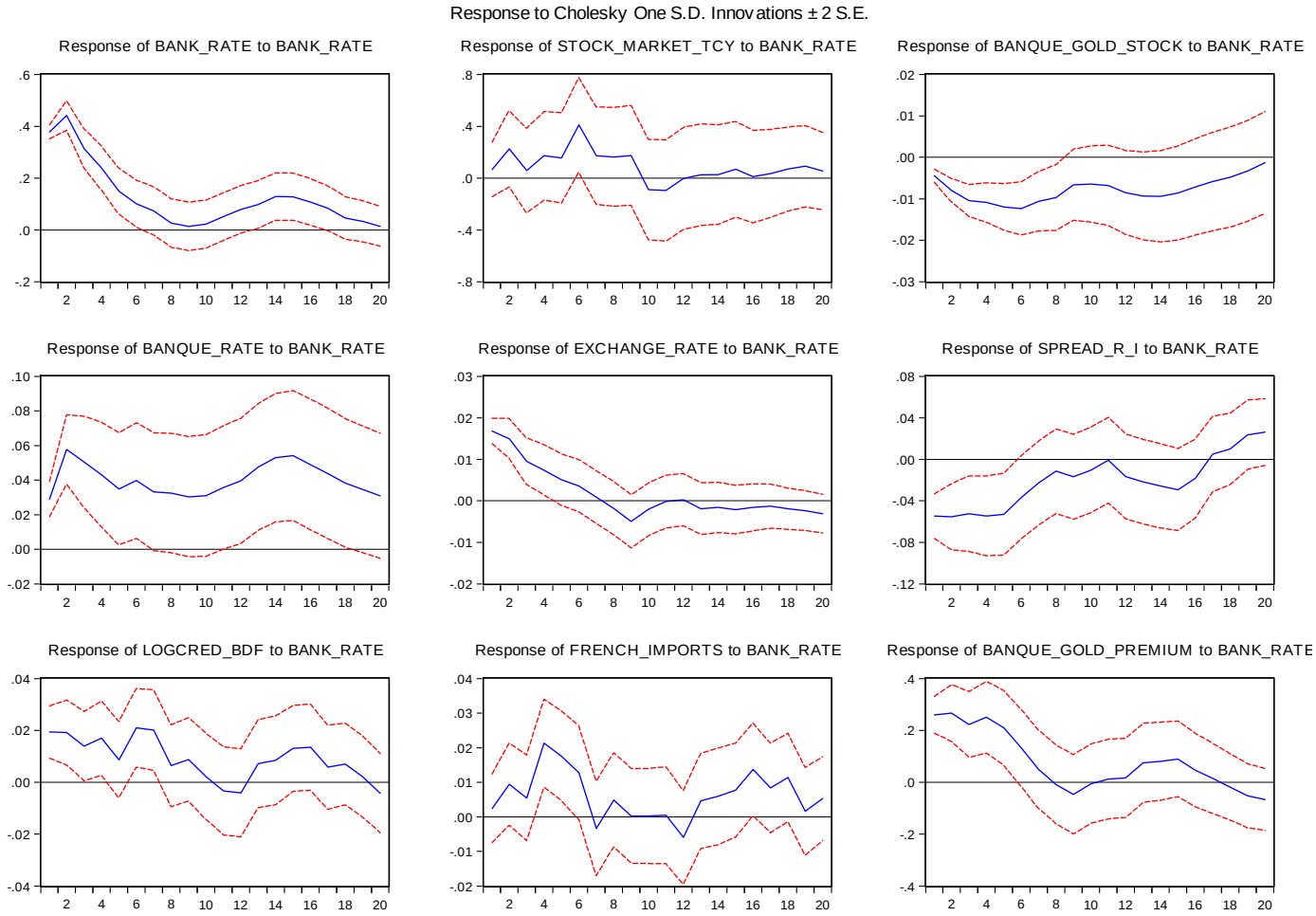
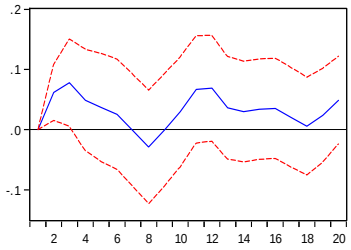

Response to Cholesky One S.D. Innovations ± 2 S.E.
Response of BANK_RATE to BANK_RATE
Response of STOCK_MARKET_TCY to BANK_RATE
Response of BANQUE_GOLD_STOCK to BANK_RATE
Response of BANQUE_RATE to BANK_RATE
Response of EXCHANGE_RATE to BANK_RATE
Response of SPREAD_R_I to BANK_RATE
Response of LOGCRED_BDF to BANK_RATE
Response of FRENCH_IMPORTS to BANK_RATE
Response of BANQUE_GOLD_PREMIUM to BANK_RATE

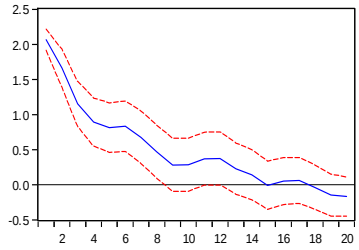
Figure 23

Response to Cholesky One S.D. Innovations ± 2 S.E.

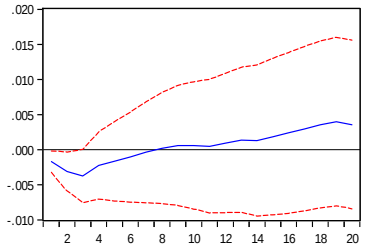
Response of BANK_RATE to STOCK_MARKET_TCY



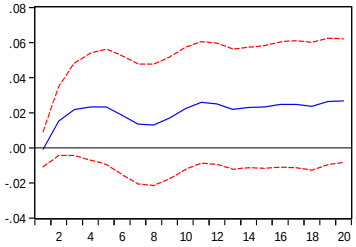
Response of STOCK_MARKET_TCY to STOCK_MARKET_TCY



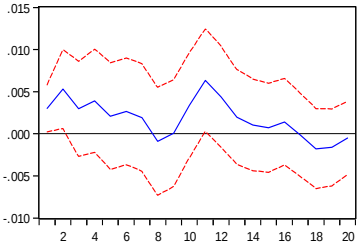
Response of BANQUE_GOLD_STOCK to STOCK_MARKET_TCY



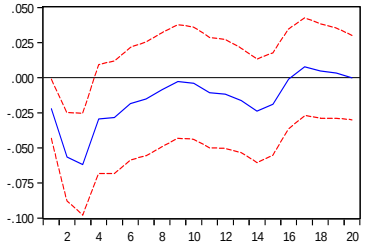
Response of BANQUE_RATE to STOCK_MARKET_TCY



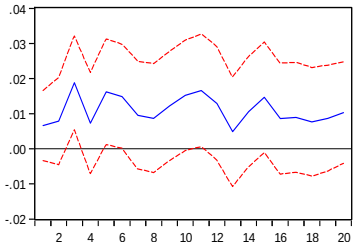
Response of EXCHANGE_RATE to STOCK_MARKET_TCY



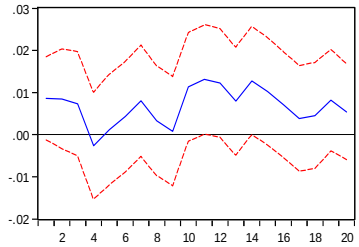
Response of SPREAD_R_I to STOCK_MARKET_TCY



Response of LOGCRED_BDF to STOCK_MARKET_TCY



Response of FRENCH_IMPORTS to STOCK_MARKET_TCY



Response of BANQUE_GOLD_PREMIUM to STOCK_MARKET_TCY

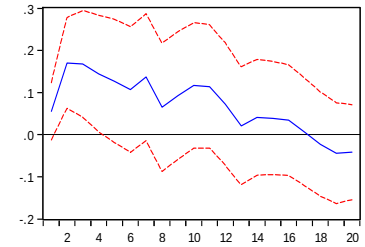


Figure 24: Probability to be in regime 2 according to the Markov switching equation, and discount rates of the Banque de France and Bank of England.

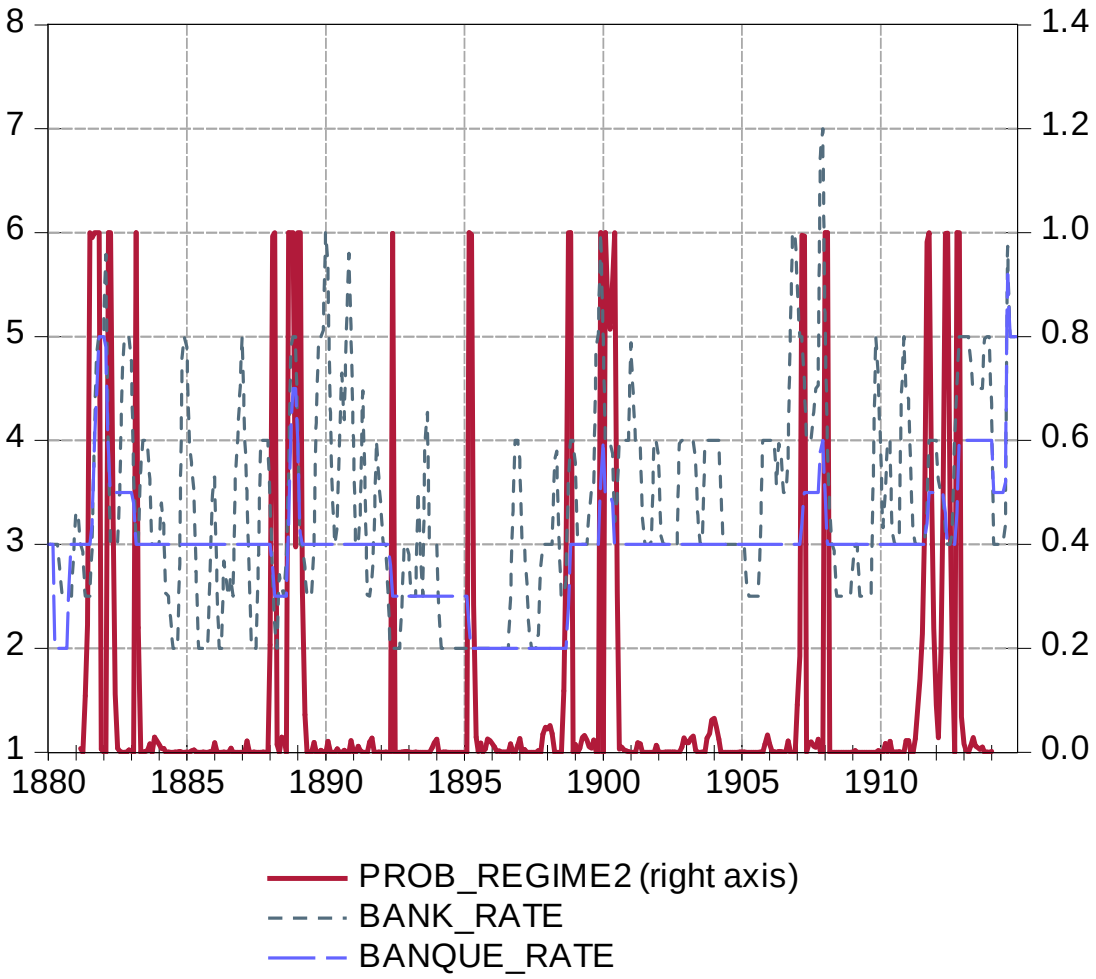


Table 1 : Determinants of Banque rate changes (Markov switching estimation)

Variable	Coefficient	Std. Error	Prob.
D(BANK_RATE)	0.010850	0.006151	0.0778
BANK_RATE(-1)	0.006093	0.003575	0.0883
SPREAD_R_I(-1)	-0.001183	0.007068	0.8671
D(BANQUE_GOLD_STOCK(-1))	0.087182	0.034242	0.0109
POINT(-1)	-0.016409	0.048571	0.7355
BANQUE_GOLD_STOCK(-1)	-0.001179	0.001146	0.3037
D(BANK_RATE)	0.568003	0.019426	0.0000
BANK_RATE(-1)	0.089444	0.013608	0.0000
SPREAD_R_I(-1)	-0.181371	0.034884	0.0000
D(BANQUE_GOLD_STOCK(-1))	-0.065140	0.023744	0.0000
POINT(-1)	-1.219417	0.183899	0.0000
BANQUE_GOLD_STOCK(-1)	-0.009224	0.004590	0.0445
LOG(SIGMA)	-2.926285	0.036907	0.0000

Table 2 : Determinants of Banque rate changes (OLS estimation)

Variable	Coefficient	Std. Error	Prob.
D(BANK_RATE)	0.119853	0.024404	0.0000
BANK_RATE(-1)	-0.006752	0.010423	0.5175
SPREAD_R_I(-1)	-0.048937	0.019531	0.0126
D(BANQUE_GOLD_STOCK(-1))	0.006325	0.052917	0.9049
POINT(-1)	-0.472308	0.158092	0.0030
BANQUE_GOLD_STOCK(-1)	0.006912	0.003398	0.0426
Adjusted R-squared	0.210645		