**Taming the Global Financial Cycle: Central bank balance sheets and the sterilization of capital flows under the Classical Gold Standard (1891 – 1913)**

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Preliminary version

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Completely monetarized communities could not have stood the ruinous effects of abrupt changes in the price level necessitated by the maintenance of stable exchanges unless the shock was cushioned by the means of an independent central banking policy. The national token currency was the certain safeguard of this relative security since it allowed the central bank to act as a buffer between the internal and the external economy. If the balance of payment was threatened with illiquidity, reserves and foreign loans would tide over the difficulty; if an altogether new economic balance had to be created involving a fall in the domestic price level, the restriction of credit could be spread in the most rational fashion, eliminating the inefficient, and putting the burden on the efficient. Absence of such a mechanism would have made it impossible for any advanced country to stay on gold without devastating effects as to its welfare, whether in terms of production, income, or employment.

Karl Polanyi, *The Great Transformation* (1944: 218)

**Abstract**

Are central banks able to isolate their domestic economy by offsetting the effects of capital flows, or are they fully constrained by international financial conditions and/or their exchange-rate regime? We provide an answer for the First Age of Globalisation based on an exceptionally detailed and standardized database of monthly balance sheets of 21 central banks (1891-1913) found in the archives of the Bank of France. Investigating the impact of a global interest rate shock on the exchange-rate, the interest rate and the central bank balance sheet, we find that not a single country played the “rules of the game.” Core countries fully sterilized capital flows, while peripheral countries relied on convertibility restrictions to avoid reserve losses. These features allowed central banks to round the corner of the *trilemma* and serve as “a buffer between the internal and the external economy”. In contrast, in the United States, a gold standard country without a central bank, the reaction of the money market rate was about 10 times higher than the interest rates of countries with a central bank. In line with the predictions of the *trilemma*, the exchange rate reacted strongly in countries off the gold standard (i.e. with a floating exchange rate), whereas the central bank's balance sheet and interest rate were not affected. This paper also provides a new method to identify sterilization by central banks. It can be extended to other periods and countries as long as detailed central bank balance sheets are available.

**Keywords:** gold standard, sterilization, rules of the game, central banking, trilemma

**JEL classification:** N10, N20, E42, E50, F30, F44

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Table of Contents

[Introduction 2](#_Toc2521971)

[A unique database on central bank balance sheets 6](#_Toc2521972)

[Sources 6](#_Toc2521973)

[Presentation of the data 8](#_Toc2521974)

[Sterilization and the “rules of the game” under the gold standard 9](#_Toc2521975)

[Definition of sterilization 9](#_Toc2521976)

[Identification of sterilization 11](#_Toc2521977)

[Theory and methods of estimations 13](#_Toc2521978)

[Theoretical predictions 13](#_Toc2521979)

[Methods of estimation 15](#_Toc2521980)

[Groups of countries 17](#_Toc2521981)

[Results 18](#_Toc2521982)

[Core countries: sterilization of gold outflows 19](#_Toc2521983)

[The gold standard periphery: imperfect convertibility 20](#_Toc2521984)

[Floating 22](#_Toc2521985)

[The United States of America 23](#_Toc2521986)

[Discussion of endogeneity and robustness checks 25](#_Toc2521987)

[Conclusions 29](#_Toc2521988)

[DATA APPENDIX 31](#_Toc2521989)

[Table A1 Summary statistics 36](#_Toc2521990)

[References 37](#_Toc2521991)

[APPENDIX 44](#_Toc2521992)

# Introduction

Countries wish to reap the benefits of financial integration while shielding themselves from the vagaries of international financial markets. But can they have it both ways? A large body of work acknowledges the constraints of a *trilemma*, in the spirit of Robert Mundell’s international macroeconomic model, pointing out that a fixed-exchange rate regime and full capital account openness lead countries to give up their monetary autonomy (Obsteld Taylor 2004, Aizenman et al. 2010, Farhi and Werning 2014 , Klein and Shambaugh 2015, Jorda, Schularick and Taylor 2019). The first era of globalization, also the period of the classical gold standard (1880s-1914), is often taken as the paradigmatic example of such constraints, with central banks changing their discount rate in function of international pressures only (Obstfeld and Taylor 2004, Bordo and James 2015). For those who believe that the constraints facing central banks do not even depend on the exchange rate regime – being a simple dilemma – (Rey 2016), the classical gold standard era (1880-1914) should have offered even fewer opportunities for any kind of monetary autonomy, given strong financial integration and the leading role of London in the international financial cycle (Lindert 1969, Eichengreen 1987).

Yet, since Arthur Bloomfield (1959)’s seminal study, economic historians have argued that gold standard’s central banks could rely on various devices (sterilization, foreign exchange interventions, convertibility restrictions) which allowed them to achieve significant levels of autonomy, breaking the “rules of the game” (Keynes) and avoiding partly the constraints of international finance. Bloomfield (1963) and Lindert (1969) further supported this claim by showing the widespread use of foreign exchange interventions by central banks at the beginning of the XXth century (although they did not look at sterilization *per se)*. It is based on these arguments that, for example, Davis, Hanes and Rhode (2009), and Hanes and Rhode (2013) argue that a US central bank – if it had existed before 1913 - could have sterilized domestic and international shocks by adjusting the money supply without endangering the country’s commitment to the gold standard. Much has been written about the gold standard, but the debate is not over whether or not central banks sacrificed their autonomy in favor of exchange rate stability and financial globalization.

Although scholars have extended and built upon the work of Bloomfield (1959, 1963) and Lindert (1969) by providing detailed case studies of operations of several central banks, our paper is the first to go back to the original comparative ambition of these two authors.[[1]](#footnote-1) Compared to our predecessors, we provide high frequency data (monthly rather than annual), a much larger sample of countries than Bloomfield (including countries not on the gold standard, for the purpose of comparison) and a new methodology to define and measure sterilization, based on the identification of the responses of central banks to international shocks. Overall, our results show that central banks enjoyed a high degree of autonomy during the gold standard period – very far from the supposed “rules of the games” – but the way to achieve this autonomy was very different depending on countries' integration into the rest of the international system.[[2]](#footnote-2)

With a new database of detailed monthly balance sheets of 21 central banks from 1891 to 1913, we systematically study how central banks reacted to an increase in the Bank of England's discount rate, the leading financial institution of the day.[[3]](#footnote-3) Our unique dataset and our research strategy allow us to study at the same time the degree of monetary autonomy (the response of the domestic rate to the English rate) and the means employed by central banks to achieve such potential autonomy (sterilization, foreign exchange interventions or imperfect convertibility). Due to data limitations on central bank balance sheets, such an approach has not been undertaken in the extant literature.[[4]](#footnote-4) Obstfeld, Schambaugh and Taylor (2005) assess the autonomy of central bank during this period (and subsequent ones) looking at the difference between the changes in the domestic rate and the leading international rate (England in this case). Likewise, Morys (2013) studies the determinants of changes in interest rates of gold standard countries but leaves aside sterilization and foreign exchange interventions. Jorda et al. 2015, 2019 use the change in the Bank of England discount rate to instrument the change in monetary policy rates in other countries under the gold standard. On recent data, Kim (2001), Bruno and Shin (2015) and Rey (2016), Miranda-Agrippino and Rey (2018) use VARs to investigate the impact of the US monetary policy rate on exchange rates, financial and real cycles of other countries, but they do not study the response of monetary authorities.

Our identification strategy extends Bazot, Bordo & Monnet (2016) and consists in looking jointly – for each central bank in our sample – at the response of the domestic discount rate, the exchange rate, the domestic assets and the international assets of the central banks, to a change in the Bank of England discount rate. This is done by estimating Local Projections with the variables mentioned above and simulating a shock to the Bank of England (BoE) rate. In a country which played the “rules of the games” and whose central bank sacrificed its autonomy, an increase in the BoE rate should be followed by an increase in the domestic central bank’s discount rate (which would then stabilize the exchange rate). If the interest rate does not react fully, the shock of the BoE rate moves down the gold reserves and depreciates the domestic exchange rate. The rules of the game then imply an equivalent decrease of the domestic assets of the central bank. The positive correlation between domestic and international assets of central banks is what Bloomfield (1959)---following Nurkse (1944)---identified as a key component of the “rules of the game” of the gold standard. On the contrary, a decrease in international assets (gold and/or foreign exchange) coupled with an increase in domestic assets (discount of commercial paper and advances on securities) is interpreted as an evidence of sterilization: the central bank compensates international assets outflows by credit creation. In a country which sterilizes, we should observe a negligible reaction of the domestic discount rate to an increase in the BoE rate but still a temporary reaction of the exchange rate.

Our estimation strategy also identifies a third case where a modest response of the domestic discount rate to the BoE rate is associated with an absence of decrease in the gold stock. We interpret such results as evidence of imperfect convertibility which prevented gold to leave the central bank in reaction to an international shock.[[5]](#footnote-5) Imperfect convertibility could mean that central banks preferred to (or were forced to) rely on some forms of capital controls (convertibility restrictions), rather than using their balance sheet to work as a buffer between the internal and the external economy. We observe a clear distinction between countries – in the core of the gold standard – which could rely on sterilization and foreign exchange intervention to achieve autonomy, and other countries – at the periphery of international capital markets – which joined the gold standard but were protected from international shocks by imperfect convertibility. In countries with imperfect convertibility, loans of the central bank to the domestic economy also increased after a rise in the BoE rate and also offset capital outflows (although central bank’s gold did not decrease). This increase in the domestic portfolio was necessary to stabilize domestic interest rates around the central bank rate, even in the absence of gold outflows.

Last, we can compare gold standard countries to countries which had a floating exchange rate during the same period. In line with the predictions of the trilemma, we find that exchange rates absorbed international shocks in these countries and that the interest rate of the central bank remained stable.

The United States of America were a prominent example of a country adhering to the gold standard without a central bank. It is the perfect counterfactual to enlighten the stabilizing role of central banks sterilization policy. In countries with a central bank, the money market rate was stabilized around the central bank discount rate because banks could borrow freely at this rate at the discount window. By contrast, the US money market rate (call rate in New York) was much more volatile because it was not stabilized by such lending operations. We show that the reaction of the New York money market rate to an increase in the BoE rate was 10 times higher than the typical response of the discount rates of central banks. In other words, in the absence of a central bank making use of their international and domestic portfolios, a (international) shock must be absorbed by interest rate change, thereby generating macroeconomic fluctuations. This explains the large volatility of the US market rates compared to those of core European countries.

Our paper not only bears some important historical lessons for the role of central banks in a globalized world. On a methodological perspective, it also provides a new and simple identification method to estimate the extent of sterilization by central banks. This new identification is meant to avoid the usual endogeneity bias that studies on central bank sterilization have faced (Obstfeld 1982). It can be extended to other periods as long as detailed statistics of central bank balance sheets are available.

Section I describes our original historical database. Sections II defines sterilization and focuses on its potential role under the gold standard. It also explains why previous empirical studies failed to identify sterilization and the method we propose to achieve such robust identification. Section III presents our method of estimation. Section IV deals with the main results of the paper. Section V discusses alternative specifications, endogeneity issues and robustness checks.

# A unique database on central bank balance sheets

## Sources

Our dataset is based on an exceptional source that has never been exploited before. The French Central Bank (*Banque de France*) began systematically collecting the weekly or monthly balance sheets of all the world's central banks in 1891. Central banks had a legal obligation to publish these balance sheets at a high frequency, in addition to their annual reports to shareholders, which generally contain additional information and sometimes reproduce the high frequency balance sheets. The legal (or in some cases customary) obligation to publish these balance sheets was justified by the legal requirements (in terms of the relationship between the currency in circulation and the reserves, or the ceilings on circulation) to which central banks were subject. These ratios were carefully looked at by policymakers and investors; they were published in major financial newspapers, as well as data on exchange rates and discount rates (e.g. *L'Economiste Européen* in France, *The Banker* in the United Kingdom, *Le Moniteur* in Belgium, see Baubeau 2018). However, newspapers did not publish data on central bank assets, which were much more difficult to harmonize and compare, given the different financial and accounting practices of countries.[[6]](#footnote-6) On the contrary, the Banque de France took on this difficult and tedious task. Sufficient skills were needed to translate and understand the various reports. A unit was created in 1884 for this purpose within the Banque.[[7]](#footnote-7) Its sole objective was to produce harmonised balance sheets of foreign central banks (it was called the *Foreign Banking Statistics Service*), and economists were hired because of their skills in understanding foreign languages (Plessis 2005). It was not until 1891 that this unit began to systematically produce ledgers with weekly or monthly statistics for a significant number of foreign central banks.[[8]](#footnote-8) Later, in the mid-1890s, it became a real research department, broadening the scope of its studies.[[9]](#footnote-9) During this period, only the Bank of England, the Banque de France and the Reichsbank had a research department (Martin-Acena & Tortella 2013) but we found no evidence of similar work in the other two central banks. From 1891 onwards, some of the statistics on the balance sheet of foreign central banks produced by the Banque de France were reproduced in the *Bulletin de législation et statistique comparées*, an important outlet for the dissemination of international economic statistics, published by the French Ministry of Finance.[[10]](#footnote-10) But they were published on a quarterly basis, without notes or sources, and were sometimes incomplete. For this reason, we use the original sources available in the archives of the Banque de France. We use monthly data to obtain comparable frequencies between central banks.[[11]](#footnote-11) In addition, we looked at the annual balance sheets, also prepared by the Banque de France, and based on the annual reports of central banks.[[12]](#footnote-12) The annual balance sheets allow us to see if some balance sheet items have been hidden in the weekly and monthly publications. On several occasions, for example, foreign exchange reserves have only been published in annual reports (it was the case only when they represented a very small share of the total portfolio). In addition, the annual ledgers contain much more information on how Banque de France economists translated foreign terms into French, as well as institutional details on foreign central banks.

## Presentation of the data

(see appendix for a more detailed presentation and summary statistics)

Following Bloomfield (1959) the analysis of central banks’ sterilization and exchange rate intervention is based on the evolution of domestic and international portfolios. Fortunately, the harmonized balance sheet provided by the source helped us to build those series. We assembled five major series in this respect: (1) metallic reserves (gold plus silver); (2) foreign papers; (3) foreign funds available into banks’ correspondents; (4) discount portfolio of domestic papers; (5) short term advances on securities and other collaterals. (1), (2), and (3) constitutes the international portfolio while (4) and (5) captures the domestic portfolio.

Time series #1 consists for the most part of gold coin and gold bullion. It occasionally also contains silver and other specie (e.g., copper and bronze in the case of Sweden). Time series #2 consists of bills of exchange drawn on foreign places. Such a series is recorded for all 21 banks in our sample, even if values are very small (Russia, Serbia), a monthly series is reported but begins relatively late (France in 1906) or the reported series only constitutes a lower-bound estimate (Romania).[[13]](#footnote-13) In the cases of Germany and Portugal, such data are only available on a yearly basis and are of very small value. The very low numbers for France and Germany suggest that central banks in mature money markets bought such bills infrequently and left this business to specialised banks and brokerage firms. By contrast, central banks in peripheral countries acquired an important share of the market for the lack of strong competitors; in some situations, they have well have constituted the only domestic buyer of bills of exchange drawn on foreign places. Time series #3 consists of funds held abroad. Such funds were usually held by so-called foreign correspondents, i.e., typically a foreign commercial bank with whom the bank of note issue was in regular contact. In many cases, fund held abroad reflect bills of exchange drawn on foreign places after reaching maturity. Such bills are classified as time series #2 before the settlement date and as time series #3 thereafter. Time series #1 is typically much larger than time series #2 and #3 combined (see Table A1 in the appendix). The Classical Gold Standard (1870s-1914) was a specie standard at its heart and a larger role for foreign exchange was left to the interwar period. There are typically more bills of exchange drawn on foreign places than foreign funds. Banks of note issue are typically last buyers (and in peripheral countries often first buyers) of such bills in the domestic market.[[14]](#footnote-14)

Time series #4 consists of bills of exchange drawn on domestic places and typically accounts for the majority of the domestic portfolio. (Re-)discounting bills of exchange was at the heart of central bank lending at the time (Bloomfield 1959 is particularly clear on this issue). In a limited number of cases, time series #4 potentially includes a certain amount of foreign bills of exchange (Germany, Portugal). End-of-year comparisons for Portugal and Germany suggest that foreign bills accounted for less than 1% and 10%, respectively. Time series #5 consists of advances. Such advances were typically made available against safe and liquid assets such as government bonds. Yet practice varied with local conditions and we witness a confusing variety of what exactly classifies as an advance. For most countries, a careful comparison of the monthly, quarterly and annual data of the Bank of France delivered the same result. Advances were only made available against safe and liquid assets and their size was small compared to discounted bills of exchange (typically a quarter).[[15]](#footnote-15) Typically, there were many more bills of exchange than advances (see Table A1 in the appendix); a predominance captured in some languages even today when a central bank’s main lending rate is referred to as “discount rate” (e.g., “Diskontsatz” in German).

It is worth noting that some additional hypotheses may have been used to build the series depending on each central bank specificities. The data appendix provides all details, justifications, and comparisons in this regard.

# Sterilization and the “rules of the game” under the gold standard

## Definition of sterilization

Following Nurkse (1944), Bloomfield (1959) and Triffin (1964), the gold standard literature uses a broad definition of sterilization. Note that these three authors, writing before Mundell, used the word "neutralization" rather than "sterilization". The recent literature in international macroeconomics (Reinhart & Reinhart 2008, Aizenman & Glick 2009, Blanchard & Adler 2015) uses sterilization in both a narrow sense (i.e sterilization of foreign exchange interventions) and in a broader sense (i.e sterilization of the effect of capital flows on the domestic money supply). The study of "neutralisation" by Nurkse and Bloomfield dealt with the money supply (although they looked only at central bank assets). It did not require the existence of foreign exchange interventions. This meaning of sterilization must be understood in the context of the price-specie flow mechanism that was supposed to be at the heart of the gold standard's operation. In this context, a deficit country loses gold, which is deflationary. This deflation would then stabilize the balance of payments because domestic goods become cheaper. In such a framework, the central bank is supposed to play the "rules of the game", i.e. to strengthen the system's natural adjustment process, which involves a price adjustment driven by capital (specie) flows. The central bank should therefore increase its interest rate when the country loses gold in order to accelerate the adjustment. On the contrary, the central bank could refuse to play the "rules of the game", and "neutralize" capital outflows by expanding domestic credit and maintaining stable interest rates when the country loses gold. The conclusion reached by Nurkse (and subsequently applied by Bloomfield to the classical gold standard) was that the absence of movement of interest rates as a function of capital flows, and the negative correlation between domestic assets and the central bank's international assets, were evidence of a "neutralization" of these flows.

The significance of sterilization (or neutralization) in the context of the gold standard is the offsetting of the effect of capital flows on the money supply. It is easy to reformulate this meaning in the context of Mundell's trilemma as a policy that gives autonomy to the central bank despite the constraints of international finance. In a context of free movement of capital and fixed exchange rates, the central bank's interest rate should be concerned with defending the peg. Therefore, when capital flows out of countries, the central bank must also increase its interest rate. Breaking the "rules of the game" is therefore equivalent to escaping the trilemma.

It was unlikely that "sterilization" would be fully deliberate in the gold standard. This point was already made by Bloomfield (1959, p. 47). First, it was not deliberate because central banks did not use minimum reserve requirements, for example, to act on money supply with the clear aim of avoiding the effects of foreign capital on the domestic price level. Second, although foreign exchange interventions were sometimes deliberate (Jobst 2009), gold sales were generally not. The loss of gold reserves is due to the fact that the agents requested to redeem their notes in gold, and not to deliberate interventions in the foreign exchange market. But, as Bloomfield pointed out, this does not mean that violating the rules of the game was not an active policy. Indeed, central banks were aware that they were not raising interest rates while they were facing a decline in their international reserves and other central banks were increasing their rates. Yet, how can we observe a negative correlation between the national and international portfolios if it was not a deliberate policy? This point was explained in Bazot, Bordo and Monnet (2016). In a world where capital mobility is perfect, an increase in the international rate pushes the domestic money market rate up due to arbitrage, while at the same time agents require foreign assets (gold or foreign exchange) from the central bank to obtain a higher return. The central bank's international assets are declining and the money market rate approaches the level of the central bank discount rate. When it becomes cheaper to borrow from the central bank rather than from the market (at least for a fraction of the banking system), the demand for borrowing increases at the central bank. In response, the central bank's domestic assets increase. However, if the central bank plays the "rules of the game", it increases its discount rate; its domestic assets will then decrease. Thus, the negative correlation between the central bank's international and domestic assets is explained by the increasing demand for borrowing at the central bank's discount window when the central bank refuses to increase its rate in line with the international rate (and in accordance with the rules of the game).

One may wonder why central banks wanted to enjoy policy autonomy under the gold standard, since macroeconomic policies, inflation targets or unemployment targets were not yet a concern of monetary authorities. Although they did not have macroeconomic objectives, central banks sought to keep interest rates as stable as possible. This objective was considered essential for the financial development of countries, and in line with the profit objective of those private institutions (Conant 1915, Bloomfield 1959, Jobst 2009, Martin-Acena et al. 2012, Bazot et al. 2016). Thus, their goal was to maintain stable domestic interest rates and stable exchange rates.

## Identification of sterilization

In order to assess whether central banks offset capital flows, Bloomfield (1959) looked at the correlation between the domestic and the international portfolio. His results were enlightening but his method suffered from a key identification problem which has not been addressed in the subsequent literature on the classical gold standard.[[16]](#footnote-16)

Measuring sterilization by looking at the simple correlation between international and domestic assets suffers from strong reverse causality and omitted variable bias (see for example Obstfeld 1982). For example, the evolution of the domestic portfolio can influence the change in the international assets if central banks decide to equalize their financial return. More importantly, many factors can influence the path of domestic assets, and might be linked to the balance of payments, such as seasonal economic shocks or banking crises. The historical literature on the gold standard (Dutton 1984, Pippenger 1984, Reis 2007, etc. ) has not taken into consideration these discussions about identification, with the exception of Bazot et al. (2016).

Omitted variable bias is likely to be even more significant in gold standard studies because researchers take into account a much more limited set of variables, given the lack of macroeconomic data for most countries. Consider, for example, a negative domestic shock on agricultural activity that, at the same time, increases borrowing from the discount window and increases imports (to compensate for crop failure) and capital outflows (Hanes & Rhode 2013). The high seasonality of domestic credit during this period has made this case quite frequent. However, it is not enough to take seasonality into account, as such domestic shocks could also occur without being seasonal. It could be the case of a banking crisis, for example, which causes at the same time an outflow of capital and an increase in the domestic portfolio of the central bank if the latter is playing the role of lender of last resort.

It is impossible to control for (or identify) these domestic shocks in our sample of countries because we have reliable monthly data on real activity for only three countries (and they do not include agricultural activity). It is obviously interesting in itself to study how central banks smooth seasonal fluctuations in domestic credit or responded to domestic banking crises. But it is left for further research. What matters for this article is to propose an identification of sterilization which is fully consistent with the original idea of Nurkse and Bloomfield and the subsequent literature on dilemma/trilemma, that is how central banks are able to offset the effect of “exogenous” international capital flows on the domestic money supply. For this reason, we follow Bazot, Bordo & Monnet (2016) who focus on a specific international shock---e.g. a rise in the BoE discount rate---which proves to be easier to identify than a domestic shock. In this set-up, a change to the discount rate of the Bank of England – the conductor of the orchestra in Keynes’ famous words, an assessment supported by subsequent research (Eichengreen 1987) – is the quintessential shock to the monetary system of another country. Balance-of-payments adjustment can come by means of (here illustrated by an *increase* of the Bank of England discount rate). The advantage of such identification is twofold. First, movements in the Bank of England (BoE) discount rate can be deemed exogenous to the behaviour of other central banks during this period (Jordà et al., 2019).[[17]](#footnote-17) Second, we can verify – for each country – whether this shock is indeed a shock that is likely to drive capital flows, by looking at the reaction of the exchange rate. If the exchange rate does not react to an increase in the BoE rate, it means that the country was not financially integrated enough to require its central bank to offset the effects of capital flows.

# Theory and methods of estimations

## Theoretical predictions

Consistent with the previous definition of sterilization, the work of Nurkse (1944), Bloomfield (1959), Mundell (1963) and recent reformulations of the trilemma in international macroeconomics (Obstfeld & Taylor 2004) imply the following theoretical predictions and potential scenarios after an increase in the discount rate of the Bank of England. The first scenario (“rules of the game”) is equivalent to the plain *trilemma* case with fixed exchange rate and full capital mobility. Scenario 2 is the same case where we consider the role of effective central bank sterilization rounding the corners of the *trilemma*, as explained in the previous section. Although discussed in theory (Mundell 1963, Obstfeld 1982), this scenario is usually not investigated in empirical studies of the trilemma. Scenario 3 is the *trilemma* case with fixed exchange rates and capital controls. Scenario 4 is the *trilemma* case with floating exchange rates.

**Scenario 1: Playing by the rules of the game**

In a country which played the “rules of the games” and whose central bank sacrificed its autonomy, an increase in the BoE rate should be followed by an increase in the domestic central bank’s discount rate (which would then stabilize the exchange rate). If the foreign central bank increases its rate by the same magnitude as the BoE, the reaction of the exchange rate may not be visible at a monthly frequency since the exchange rate adjusts quickly through the uncovered interest rate parity. If the exchange rate does not adjust immediately and the shock of the BoE rate is large enough to move down the gold reserves, we should observe an equivalent decrease of the domestic assets of the central bank. The positive correlation between domestic and international assets of central banks is what Bloomfield (1959)---following Nurkse (1944)---identified as the second key consequence of the “rules of the game” of the gold standard: a central bank was meant to exacerbate the external shock in order to accelerate the adjustment process.

**Scenario 2: Sterilization**

On the contrary, a decrease in international assets coupled with an increase in domestic assets is evidence of sterilization. The central bank compensates capital outflows by credit creation. It offsets the effect of international capital flows on the money supply. Expanded credit means that the discount rate needs to be raised by less than under scenario 1; consequently, we should observe a smaller reaction of the domestic discount rate to an increase in the Bank of England rate. As explained above, the central bank increases its lending to domestic banks because the increase in the BoE rate increases the domestic money market rate, and thus, the demand of banks at the central bank discount window. The alternative choice for the central bank would be to follow the increase in the domestic money market rate, thus acting as in scenario 1.

As long as the central bank is committed to convertibility (unconditional and immediate conversion of bank notes into gold), the exchange rate should be quick to come back to mint parity because of gold outflows or foreign exchange intervention.

Sterilization does not prevent the global functioning of the Gold Standard either, i.e gold flows playing a strong stabilizing role. To understand this point let's assume that an investor wants to invests its Ff. on bills. If the interest spread with London is negative she prefers to invest in UK bills. However, the success of such operation declines as the Ff. depreciates along with arbitrage activities (the uncovered interest rate parity holds). Because the mint parity is fixed, investors may find profitable to change their Ff. into gold and change gold into £ to invest in England. Therefore, as the exchange rate approach the gold point, it becomes more lucrative to send gold into London despite gold transportation cost.[[18]](#footnote-18) In other words, as the gold point threshold is reached, investors convert their Ff. into gold, transport gold to London, and convert gold into £ to buy English bills. As gold inflows into England, the £ depreciates while the supply of money increases and the London open market rate declines. This ultimately leads the BoE to bring the discount rate back to its previous value (Jeanne, 1995).

**Scenario 3: Imperfect convertibility**

We expect the impact of the exchange-rate to be larger only in cases of imperfect convertibility (restrictions on convertibility between notes and gold at the central bank). Gold devices widen the gold points, allowing the exchange-rate to depreciate further than in scenarios 1 and 2. Such policies aimed at protecting international reserves and reducing the interest rate adjustment; in both variables, we expect a smaller response than in scenarios 1 and 2. In the absence of a large reserve outflow, the central bank might nevertheless increase domestic credit. Imperfect convertibility mitigates the decrease of gold reserves by the central bank but does not necessarily prevent outstanding gold from leaving the country. Thus, central bank credit must expand to avoid any increase in market rates and offset the effect of gold outflows on the aggregate money supply.

**Scenario 4: Countries off gold**

A fourth scenario is concerned with countries on a floating exchange-rate. If these countries have an opened capital account, the exchange rate is going to react to the shock to the BoE discount rate. The exchange rate fully absorbs the shock, so that the domestic central bank does not need to respond by expanding domestic credit or increase its discount rate. By contrast, if financial integration is weak, the exchange rate does not react and, in this case, we do not expect any reaction from the central bank either.

## Methods of estimation

We want to study in a panel data set the reaction of central banks’ balance sheets to an exogenous increase in the BoE rate. Following a now well-established literature (Ramey 2016, Jordà, Schularick & Taylor 2019) we turn to local projections to estimate the effect of a single monetary shock in a panel of countries. In this respect, Jordà (2005) proposes to estimate impulse-response (IR) directly without relying on a predetermining model. This contrast with IR from VAR estimation which simulates the iterative effect of a shock based on a set of estimated parameters. In other words, unlike IR from VAR, the data generating process does not assume that the true model has been estimated. For that reason, the local projection is not a parametric procedure.

Local projections are based on regressions explaining each horizon for each variable of interest. Each regression uses a set of control variables---which may be the lag operator conventionally used in a VAR. The response is then based on the following regression:

for

Where is the variable of interest, the vector of control variables, the polynomial set of lag operator (which is set at 3 in our analysis), the identified shock, and the residual. The right hand side of the equation may include the lag of the explained variable into . The IRF is then based on the estimation of from to . A sequence of is produced for each variable of interest independently from the other variables response.

Local projection offers numerous advantages compared to the usual VAR. First, unlike VAR it does not have to rely on an underlying model to provide IR. This issue is particularly salient in panel as PVAR are subject to numerous pitfalls and assumptions. For instance, PVAR needs to rely on costly GMM procedure due to standard errors misspecification as fixed effects are included in the model. In addition, since the number of endogenous variables that can be included in the model explodes as the number of panel increases, one has to restrict the number of estimated parameters to avoid over-fitting. This means to assume that the estimated coefficients used to simulate a shock are the same for all panel. Because heterogeneity is lost, the chance for the IRF to rely on the true predetermining model gets smaller. Bayesian procedure may be used to circumvent this issue but at the cost of determining priors. Because LP is not parametric, it is more parsimonious and more robust to misspecification. Second, local projection does not have to assume a set of endogenous variables. In other words, the unanticipated change of the Bank of England discount rate is not assumed to depend on the other variables of the model when is estimated. For example, unlike PVAR IRF, local projection does not pre-determine any effect of country’s average change in central banks’ domestic assets on the BoE discount rate. Third, local projection is more flexible to state-dependent variables. We can thus include a “Gold Standard” and a “core-periphery” dummy variable to interact with the set of control variables. This allows the response to account for countries’ categorization when the shock occurs. As such, the model we test is the following:

is a Gold Standard dummy variables equal to 1 if the country adheres to the Gold Standard at time , is a dummy variable equals to 1 if the country has been classified as a core country in Martin-Acena et al. (2012). , , , and , are picked up from to , to build IRF for each group. Because core countries are all in the Gold Standard during the period, , so that is not part of the estimation. Thus, corresponds to core countries response (group 1), corresponds to peripheral countries in the Gold Standard response (group 2), and corresponds to peripheral countries out of the Gold Standard response (group 3).

Local projection may also come at some costs. First, observations from the end of sample are lost as increases. Second, as shown in Ramey (2012) and Ramey and Zubairy (2018) shorter run analysis should be given priority as local projection tend to provide both erratic and significant oscillating responses at longer horizons. However, because our analysis is mostly based on short run adjustment, we do not see this as a fundamental issue.

The variables of interest included in our estimations are the following: The BoE discount rate change, the log of total international assets, the log of total domestic assets, the central bank discount rate, and the exchange rate deviation from mint parity. The vector of control variables is composed of three lags for each variable of interest. Panel data unit root tests have been performed based on fisher-type tests and Im-Pesaran-Shin tests.[[19]](#footnote-19) Non-stationarity is always rejected at 1% confidence interval. Each regression includes fixed effects while standard errors are robust to heteroskedasticity and serial correlation due to clusters or Newey West estimations.

## Groups of countries

As explained above, the reason we want to distinguish between the core and periphery of the gold standard is that we suspect that, as Martin-Acena et al. (2012) suggests, “imperfect gold convertibility was the norm in the peripheral gold standard countries". If we do not take into account the potential use of such capital controls, we might misinterpret the response of central banks' balance sheets to an international shock.

We rely on previous authors to determine whether a country was in the gold standard and whether it belonged to the core or the periphery. The dates of entry and exit in the gold standard are usually uncontroversial in the literature (see Morys (2013) and Mitchener and Weidenmier (2015) for recent accounts). Note that while most countries abandoned the gold standard in the summer of 1914, the Balkan countries did so during the Balkan war that started in autumn 1912. Italy is the only case subject to discussion. The country legally abandoned the gold standard in 1893 but, from 1903 to 1911, “shadowed” the gold standard by stabilizing its exchange rate within gold points (Fratianni & Spinelli (1983) and Cesarano et al. (2012)). Hence, following previous authors, we consider that Italy was in the gold standard from 1903 to 1911.

The distinction between core and periphery is more debated although disagreements are in fact minor. Morys (2013) reviews the literature on this issue. A core country is defined as one which is fully integrated to the international financial system. Liquidity in the foreign exchange market and the functioning of a mature domestic money market are seen as important criteria in this regard. This definition is fully consistent with our approach since we want to isolate peripheral countries as countries that potentially relied more on capital controls. Together with England, the uncontroversial peripheral countries are Germany, France, Netherlands and Belgium. Denmark and Austria-Hungary are also sometimes included in this group. In the case of Austria-Hungary, there is in particular a lot of recent evidence that there were very liquid foreign exchange and money market in Vienna (Jobst 2009). In addition to Germany, France, Netherlands, England, Belgium and the United States, Austria-Hungary is the only country for which we have a money market rate with shows high frequency fluctuations during this period (see the database of Neal and Weidenmier (2003) reporting series published in The Economist) . For this reason, we include Austria-Hungary in the group of core countries. But none of our results and conclusions presented below are changed if Austria-Hungary and Denmark move from one group to another.

|  |  |  |
| --- | --- | --- |
| **Core** | **Gold standard Periphery** | **Off gold** |
| **Germany, France, Netherlands, Belgium, Austria-Hungary** | **Norway, Sweden, Denmark, Finland, Romania (until 11/1912), Japan (after 10/1897), Russia (starting 01/1897), Italy (01/1903-09/1911), Bulgaria (01/1906-09/1912), Serbia (07/1909-09/1912), Greece (starting 01/1910)** | **Portugal, Spain, Russia (before 01/1897), Italy (before 01/1903; after 09/1911), Greece (before 01/1910), Bulgaria (Before 01/1906; after 09/1012), Serbia (before 07/1909;  after 09/1912) Romania (after 11/1912)** |

Table 1: Groups of countries

# Results

In the Figures below, we look at the responses of the following variables to an increase in the discount rate of the Bank of England (BoE):

* “rate” is the discount rate of central banks
* “international” is the log of international portfolio of central banks
* “domestic” is the log of domestic portfolio of central banks
* “x” is the exchange rate between London and each country in our sample (% deviation from the mint parity). An increase in “x” is a depreciation of the domestic currency relative to the pound sterling.[[20]](#footnote-20)

By construction, the effects estimated though the local projections start one period after the shock. So, one should look at the IRFs starting at t=1.

## Core countries: sterilization of gold outflows

Figure 1 shows how core countries reacted to a shock on the BoE discount rate. They increased their interest rate by a very small magnitude: 5 basis points after a shock of 100 basis points. The interest rate pass through is much lower than 1 (for a similar finding from a different estimation perspective cf. Shambaugh et al. 2005 and Morys 2013). This imperfect pass-through allows for arbitrage in international markets. The exchange-rate depreciation is noticeable (+0.08%, with positive values denominating depreciations), but remains within the gold points and smaller than in peripheral countries (see Figure 2). As core countries offered unlimited convertibility, the international portfolio declines quickly and substantially: Yet core countries dilute the impact of this reserve drain by expanding domestic credit. This is exactly what Nurkse and Bloomfield called “neutralization” (sterilization). The reaction of the domestic portfolio is about five times larger than the reaction of the international portfolio (consistent with the result of Bazot et al. 2016 on France). It was required to sterilize fully the shock, given that foreign assets exiting the vaults of the central bank were not the integral part of capital outflows. This expansion of lending to the domestic economy responded to the demand of domestic banks at the central bank discount window. Thus a reaction of such magnitude was necessary to bring down the domestic money market rate below the official discount rate of the central bank. In sum, core countries live up to the formal requirement of the gold standard – that is, convertibility – while sheltering the domestic economy from the vagaries of the international cycle as best they can.



Figure 1. The reaction of central banks in core countries to an English discount rate shock

Sources: Own calculations based on sources as described in the appendix.

## The gold standard periphery: imperfect convertibility

The most striking difference between Figure 2 and Figure 1 is the absence of immediate reaction in the international portfolio in the periphery. It confirms the statement of Martin-Acena et al. (2012) on the absence of gold convertibility, which – to our knowledge – had never been assessed quantitatively.[[21]](#footnote-21)

Not surprisingly, this is accompanied by a much wider and longer reaction of the exchange rate (0.20% vs. 0.08%). Imperfect convertibility allows countries to let the exchange-rate depreciate far more strongly than under the scenario of perfect convertibility between gold and domestic currency. Core countries could not afford such depreciation, as gold points were narrow between Europe’s financial centres and their commitment to convertibility beyond doubt. Yet in the case of Romania, a typical peripheral country, it was well understood at the time that the National Bank of Romania typically sought to delay convertibility and/or put upper ceilings to the amount the central bank converted (Sonndorfer 1905). While in theory committed to convertibility to boost the country’s credentials, practice often fell short of it.

In sum, peripheral countries were able to shelter from the global cycle by potentially imposing capital controls. This deviation from a central pillar of the gold standard made their adherence less credible (Mitchener&Weidenmier 2015), but did allow them to combine quasi fixed-exchange rates (with larger bands) with a certain level of monetary policy autonomy.



Figure 2: The reaction of central banks in peripheral countries to an English discount rate shock

Sources: Own calculations based on sources as described in the appendix.

Two other characteristics are worth mentioning. First, as in the core countries, the discount rate reacted significantly to the English shock (in line with the results of Morys (2013)). Figure 3 shows that this was not the case in countries out of the gold standard with a floating exchange rate. Second, the central bank's domestic portfolio increased, although there was no loss of foreign exchange reserves in the central bank. Therefore, after an increase in international interest rates, the national central bank had to extend credit to the domestic economy in response to the banks' demand at its discount window. This finding means that there was still a transmission of the change in the English interest rate to the domestic money market in the periphery, so that it became cheaper to borrow from the central bank than from the private market. Restrictions on gold convertibility could protect the central bank's cover ratio (ratio of reserves to banknotes) and widen the exchange rate range, but they were not sufficient to completely isolate the country from international financial markets (as shown by the fact that the exchange rate fluctuates). Sterilization was still necessary to stabilize the money supply and domestic interest rate, but of a lower order of magnitude than in the core countries.

## Floating



Figure 3 The reaction of central banks off the gold standard to an English discount rate shock

Sources: Own calculations based on sources as described in the appendix.

In line with the predictions of the trilemma (Obstfeld and Taylor 2004), countries that are not in the gold standard could simply float their exchange rates in response to an international shock, as shown in Figure 3. The exchange rate response dramatically exceeds that of the core and peripheral countries in the gold standard. The adjustment is made entirely through the exchange rate, so that the central bank has no reaction, either in its discount rate or in its balance sheet.

## The United States of America

The most important country without a central bank during this period was the United States. It was on the gold standard although this system was more contested than in many other countries and political support for bimetallism remained strong until the early 20th century. A large number of studies have examined what could have happened to the U.S. economy if a central bank had existed there before 1913. There is consensus that a central bank would have smoothed seasonal fluctuations in credit and interest rates and perhaps reduce the frequency of banking crises (Mankiw & Miron 1986, Davis, Hanes & Rhode 2009, Hanes & Rhode 2013, Bordo & Wheelock 2011). However, precise comparisons with central bank operations over the same period remained limited due to the lack of data.

A simple extension of our previous analysis is to compare the reaction of the US economy to that of countries with a central bank. This is what Figure 4 does. The United States had no central bank, so the Treasury was responsible for backing banknotes in circulation with gold.[[22]](#footnote-22) An increase in the BoE rate is followed by a decrease in the gold held by the U.S. Treasury. The reaction of the New York exchange rate to London is not significant. This could be explained by the fact that the money market rate in New York reacts immediately and very strongly. The response of the New York money market rate is the most important result of Figure 4, since it is ten times higher than the reaction of the discount rates of the central banks of the gold standard countries.[[23]](#footnote-23)

Figure 5 illustrates more clearly the difference between a country with a central bank and a country without a central bank. We compare the money market rate in New York with central banks’ discount rates and money market rates in the core European countries. In core countries with a central bank, the money market rate is always below the central bank discount rate. As explained above, this is because any bank can borrow from the central bank with eligible collateral if the central bank's discount rate is lower than the money market rate. Central banks therefore stabilized the money market rate around their discount rate by increasing their lending in response to bank demand at the discount window.[[24]](#footnote-24) Without a central bank, the New York money market rate has a much higher volatility. Even if the US Treasury used restrictions on gold convertibility, there was no central bank to provide credit and stabilize the money market rate, as it was the case in core and peripheral economies in the gold standard with a central bank.



Figure 4: The reaction of the United States to BoE discount rate shock

Sources: Own calculations based on sources as described in the appendix.



Figure 5: Comparisons of the money market rate in New York with the average of central bank’s discount rates and money market rates in core countries with a central bank (Germany, Belgium, Netherlands, Austria, France; England is excluded). 1890 – 1913. End of the month values.

Sources: Neal and Weidenmier (2003)

# Discussion of endogeneity and robustness checks

So far we used the change in the BoE discount rate to estimate central banks reaction to an international shock. For our identification to be reliable, the increase in the English rate should be exogenous to the behaviour of other central banks. Several authors have shown that the BoE was first to move its rate among the other important central banks (Lindert 1969, Eichengreen 1987, Morys 2013, Bazot et al. 2016). A change in the interest rate of the Bank of England was not sufficient to lead to changes in the rates of other central banks. But it was a necessary condition. A recent literature relies on this assumption to identify monetary policy shocks in a number of countries (Jorda, Schularick & Taylor 2015, 2019). These authors call the *trilemma instrument* the identification that, in a fixed exchange rate regime, the interest rate of the leading central bank (England in the case of the classical gold standard) determines exogenously the interest rates of other central banks.

Let us discuss, however, how our results would be affected if the changes in the English discount rate takes place in reaction to changes in English domestic variables that would be correlated with international factors. This might be the case for three reasons. First, if the BoE changes its discount rate in reaction to gold outflows, this should coincide with international reserves increase in other central banks balance sheet. This would underestimate the effect of the shock on the international portfolio. Second, the same reasoning applies if the BoE react to a depreciation of the £ compared to other currencies. Then we would underestimate the depreciation of foreign exchange rate in reaction to a English monetary policy shock. Third, if the BoE increases its discount rate in response to inflationary demand pressures (high growth), and if there is a common international business cycle, then the positive response of the domestic portfolio of foreign central banks may in fact reflect the positive international business cycle that the BoE is responding to. In this case, we would overestimate the reaction of the domestic portfolio to an English monetary policy shock.

We believe that those issues do not significantly affect our results. As a matter of fact, each group of counties react differently to the same BoE shock. This suggests that there is no systematic bias driving the results towards one unique conclusion. Second, if one assumes that an international business cycle is at work, its frequency was surely not of one or two months. In our LP, the response of the domestic portfolio is a very short term reaction, not a hump shaped reaction function that would suggest a common mid-term cycle across countries.

In order to address those issues with econometric robustness checks, we follow Lennard (2018) who build a series of exogenous English monetary shocks during this period, in the spirit of the narrative approach of Romer and Romer (2004). To build a monetary shock, Lennard proposed to purge the series from the endogenous component of monetary policy changes. As such, the residual of a regression explaining the BoE discount rate by the BoE gold stock change, the wheat price inflation rate, and the exchange rate change with M. and Ff. among other variables is used as a measure of exogenous monetary policy shocks. In other words, the monetary policy shocks series is the deviations of the Bank of England's discount rate from the average response to current macroeconomic conditions. Figures 6 to 9 displays LP results with monetary shock instead of BoE discount rate variation. The results appear very similar to those produced in figure 1 to 4, confirming the lack of endogenous biases affecting our estimations. However, one might still expect some effect of the economic cycle. The appendix to this paper address this issue adding railways bills into LP estimation as a proxy of the UK business cycle. Results remain unchanged (see figure A3).



*Figure 6*: The reaction of central banks in core countries to a BoE monetary shock



*Figure 7*: The reaction of central banks in peripheral countries to a BoE monetary shock



*Figure 8:* The reaction of central banks off the Gold Standard countries to a BoE monetary shock



Figure 9: The reaction of the United States to a BoE monetary shock

# Conclusions

Based on monthly balance sheets of 21 central banks during the gold standard period, this paper investigates how foreign central banks reacted to an increase in the Bank of England interest rate. We consider the BoE rate as a driver of the international financial cycle and, thus, as an exogenous shock on foreign countries. Indeed, the exchange rate responds significantly to this shock in financially integrated countries. With this new dataset and identification method, we revisit the standard debate on sterilization and the rules of the game during the gold standard, offering the first comparative perspective on the matter since the work of Bloomfield (1959). Our work also informs the current debate on dilemma/trilemma and on the potential effect of movements in the US interest rate on foreign economies. We show that not a single central bank followed the “rules of the game”. Instead, we identify different patterns of behaviour among central banks. Central banks in core countries sterilized fully their decrease in international assets whereas central banks in the periphery had to rely on imperfect convertibility.

Our investigation is based on data of all central banks of the period (the Ottoman bank is considered as being more a private bank that a central bank; the central bank of Switzerland was created in 1908 only, so is not included here for investigation). But many countries during this period were on the gold standard without having a central bank. The case of the United States shows very clearly that a country without a central bank faced a much stronger response of interest rates to international shocks. As suggested by Polanyi in the quote in the epigraph of this article, central banks served as a buffer between international capital flows and the domestic financial system. As suggested by the debates in the US at the turn of the century, it was difficult to grow as a financially integrated country without a central bank.

A note of caution is necessary to avoid misinterpretation of our results. We do not claim that countries with a central bank enjoyed full autonomy, in the sense that they could join the gold standard without costs and that financial integration was beneficial for all. Globalization led some countries in the periphery to borrow too much and it ended in public debt crises which had negative political and economic consequences (Mitchener & Weidenmier 2010, Tuncer 2015). Our demonstration deals with how central banks could be in the position to maintain a stable interest rate when the leader of the international system moved its interest rate. This is the narrow definition of autonomy that we have investigated here, consistent with standard international macroeconomic models and the literature on the *trilemma*. The existence of such a monetary autonomy is however striking because it explains how central banks of the gold standard era managed to achieve their dual objectives: stability of domestic interest rates and stability of the peg. Our results are also consistent with, and are able to explain, the findings of Mitchener of Weidenmier (2015) who observed persistent spreads between the English rate and the domestic rate in the peripheral countries of the gold standard. It means that peripheral countries could use tools to mitigate the adverse short-term effects of capital flows on the domestic money supply but they had to keep higher interest rates.

The main message of this paper - in the spirit of Polanyi and Bloomfield - is that the gold standard was not a rigid framework and that its operation allowed central banks to use various tools to offset the short-term impact of international financial shocks. The sterilization of international shocks and capital controls (on gold convertibility) were so systematic in countries with a central bank that they can only be interpreted as the norm. By offsetting some of the potential negative effects of financial globalisation, these arrangements may have made a significant contribution to the stability and long life of the gold standard. It provides important lessons for today because it shows the key role that central banks can play in a globalised world, even if they face some general constraints due to fixed exchange rates and capital mobility. This lesson is particularly important for countries in a monetary union, as it shows how central banks can absorb asymmetric shocks by using their balance sheets despite the fixity of the peg. It is valid for the euro area, where the decentralised framework of the Eurosystem's monetary operations allows national central banks to increase credit in order to stabilise domestic interest rates in the event of a negative financial shock in a country (Bazot, Monnet, Morys 2019). However, as Eichengreen (1992) points out, the sterilization observed by Bloomfield was a response to short-term shocks indeed; persistent imbalances were not sustainable. Countries left the gold standard when their fiscal policy or war spending did not allow them to make anchoring credible (Bordo & Kydland 1995). The way in which systematic short-term deviation from the “rules of the game” interacted with compliance with fiscal and monetary rules in the medium-term should be further examined.

# DATA APPENDIX

**Description of balance sheet data found in the Banque de France archives**

The harmonized balance sheet provided by the source helped us to build those series. We assembled five major series in this respect: (1) metallic reserves (gold plus silver); (2) foreign papers; (3) foreign funds available into banks’ correspondents; (4) discount portfolio of domestic papers; (5) short term advances on securities and other collaterals. (1), (2), and (3) constitutes the international portfolio while (4) and (5) captures the domestic portfolio.

In describing the data below, we will also provide the French terminology based on the monthly, quarterly and annual publications of the Bank of France we rely on. Some of the notions do not lend themselves to a straightforward translation into English. This largely reflects the fact that the Bank of England followed a unique classification due its separation of an issuance and a banking department (1844 Bank Act); and that the U.S. did not have a central bank at all until the establishment of the Federal Reserve in 1913. By contrast, continental European terminology and classification is often rather similar to French practice, as evidenced by country-specific balance sheet data which we have consulted on various occasions to double-check specific issues. We therefore provide below the German equivalent of a French term in some instances.

**International portfolio**

**1. metallic reserves / “en caisse” / “Barvorrat”**

Time series #1 consists for the most part of gold coin and gold bullion. It occasionally also contains silver and other specie (e.g., copper and bronze in the case of Sweden). The proportion of silver is typically large only when silver coin retained its legal tender status after the country switched to gold at some point in the 1870s. This was often the case in countries of the so-called limping gold standard (also referred to as limping bimetallism) which preserved silver as legal tender up to a certain amount. Contemporary sources refer to the entirety of specie as „metallic reserves“ (e.g., „Metallvorrat“ for the Reichsbank).

For some banks of note issue, “reserves” (Reichsbank: “Barvorrat”) are a slightly broader concept than “metallic reserves” (Reichsbank: “Metallvorrat”). In the cases of multiple banks of note issue (Germany, Italy and Sweden in our case), the category „en caisse“ / „Barvorrat“ also encompasses bank notes issued by other (domestic) banks of note issue. The Reichsbank, for instance, was allowed to include bank notes issued by other German banks of note issue on the grounds that such notes enjoyed metallic backing by their respective issuing bank. We follow this practice, not least because the Bank of France statisticians fully subscribed to it despite coming from a single bank of note issue system.

In the cases of the Reichsbank and the three Italian banks of note issue (National Bank of the Kingdom of Italy, Bank of Naples, Bank of Sicily), we add – in line with domestic and French practice at the time – short-term treasury notes („Reichskassenscheine“ for the Reichsbank and „billets et bons de caisse de l‘Etat“ for the three Italian banks). These were highly liquid debt instruments and the four banks were allowed to include them into their note cover. It remains unclear why only these four banks of note issue include such notes into their note cover, and whether there is a connection to the system of multiple banks of note issue prevalent in Germany and Italy.

The items described in the two paragraphs above were typically very small. E.g., in the case of the Reichsbank, they accounted for approximately 5% of total reserves.

**2. foreign paper / “portefeuille commercial – papier étranger” / “auswärtige Wechsel”**

Time series #2 consists of bills of exchange drawn on foreign places. Such a series is recorded for all 21 banks in our sample, even if values are very small (Russia, Serbia), a monthly series is reported but begins relatively late (France in 1906) or the reported series only constitutes a lower-bound estimate (Romania). In the cases of Germany and Portugal, such data are only available on a yearly basis and are of very small value.

The very low numbers for France and Germany suggest that central banks in mature money markets bought such bills infrequently and left this business to specialised banks and brokerage firms. By contrast, central banks in peripheral countries acquired an important share of the market for the lack of strong competitors; in some situations, they have well have constituted the only domestic buyer of bills of exchange drawn on foreign places.

We acknowledge that the cases of Portugal, Russia and Serbia are difficult to square with this explanation. Yet the very low numbers in these three cases might reflect country-specific idiosyncrasies. In the case of Russia, the treasury – and not the bank of note issue which we study – managed foreign bills. Portugal was not on gold in the time period under investigation. The case of Serbia might be similar to the Portuguese case. We have positive knowledge of no foreign bills until 1904 (when the country was on a fiat standard), but cannot be entirely certain for the period thereafter (data for 1905-1013 only report “portefeuille commercial” without distinguishing between foreign and domestic) which roughly coincides with the country’s de facto adherence to gold (1904-1912).

**3. foreign funds / „fonds à l’étranger“ / „Auslandsguthaben“**

Time series #3 consists of funds held abroad. Such funds were usually held by so-called foreign correspondents, i.e., typically a foreign commercial bank with whom the bank of note issue was in regular contact. In many cases, fund held abroad reflect bills of exchange drawn on foreign places after reaching maturity. Such bills are classified as time series #2 before the settlement date and as time series #3 thereafter.

None of the five core countries (Britain, France, Germany, Belgium and the Netherlands) report such a series, but all other countries do with the exception of Japan, Portugal and Romania. We hypothesize that core countries stabilised their exchange-rate in the currency market located in their own country, thereby avoiding the need to hold foreign funds abroad; such exchange-rate stabilisation policies pursued domestically were probably carried out by selling bills of exchange drawn on foreign places (time series #2). Such purely domestic intervention was not possible for all other countries where currency trading took place abroad rather than at home.

Japan, Portugal and Romania are the only peripheral countries to not report such a series. In the case of Portugal, the absence might be explained by the country being off gold at the time (similar to the absence of time series #2, cf. above). The annual balance sheet of the Bank of Portugal reports a very little amount of foreign bills (less than 1% of total discounts portfolio). The Romanian case might be similar to the Austro-Hungarian case where, if only relying on published documents at the time, we would only have a lower bound estimate for time series #2 and no data at all for time series #3 (Jobst&Scheiber 2014 for Austria-Hungary vs. Stoenescu et al. 2014 for Romania). The Japanese case awaits further investigation.

**Comment on the relative sizes of time series ##1, 2, 3**

*Exceptions to #1 > > #2 + #3*

Time series #1 is typically much larger than time series ##2 and 3 combined. The Classical Gold Standard (1870s-1914) was a specie standard at its heart and a larger role for foreign exchange was left to the interwar period.

Yet the gold exchange standard of the 1920s finds some precedents among late-stabilizing countries on the European periphery, namely Bulgaria (stabilises in 1906) and Greece in particular. In the case of Greece, foreign funds account for the largest share of the international portfolio; foreign funds exceed metallic reserves by factor 7 at the time of currency stabilisation in 1910 and by factor 10 at the end of our period.

The other exception to the rule *#1 > > #2 + #3* were the Nordic countries of Finland, Norway and Sweden (though not Denmark). The combined of ##2 and 3 are often larger than #1, and foreign funds in particular played an important role. This reflects the fact that these three countries were allowed, as members of the Scandinavian Monetary Union, to include foreign funds held at the banks of note issue of the other members countries as part of their note cover (and hence as international portfolio in our terminology) See Sumner et al. (1896), Lévy (1911), Conant (1915).

*Exceptions to #2 > #3*

There are typically more bills of exchange drawn on foreign places than foreign funds. Banks of note issue are typically last buyers (and in peripheral countries often first buyers) of such bills in the domestic market. We note that the only cases in which foreign exchange is typically larger than bills of foreign exchange are the four Nordic countries, Bulgaria and Greece. In the Nordic countries, this probably reflects the privileged situation which foreign funds enjoyed due to the rules of the Scandinavian Monetary Union referred to in the paragraph above. In the other two cases, it might reflect the mechanics of late stabilisation (in the case of Greece, we cannot even identify a separate time series #2, even though the data description of time series #3 in Lazaretou (2014) leaves open the possibility that some of the foreign funds were actually foreign bills of exchange).

**Domestic portfolio**

**4. domestic paper / “portefeuille commercial – papier indigène” / „Diskontdarlehen“ or „Wechsel“**

Time series #4 consists of bills of exchange drawn on domestic places and typically accounts for the majority of the domestic portfolio. (Re-)discounting bills of exchange was at the heart of central bank lending at the time (Bloomfield 1959 is particularly clear on this issue).

In a limited number of cases, time series #4 potentially includes a certain amount of foreign bills of exchange (Germany, Portugal). Yet we do know from the Bank of France Annual Data that these amounts were very small compared to domestic bills of exchange. End-of-year comparisons for Portugal and Germany suggest that foreign bills accounted for less than 1% and 10%, respectively.

**5. advances on collateral / „avances“ / „Lombarddarlehen“**

Time series #5 consists of advances. Such advances were typically made available against safe and liquid assets such as government bonds. Yet practice varied with local conditions and we witness a confusing variety of what exactly classifies as an advance. For most countries, a careful comparison of the monthly, quarterly and annual data of the Bank of France delivered the same result. Advances were only made available against safe and liquid assets and their size was small compared to discounted bills of exchange (typically a quarter).

Only the cases of Bulgaria, Denmark, Greece, Norway, Russia, Serbia and Sweden posed specific problems. Incidentally, these seven countries were also the cases where time series #5 was large relative to time series #4 and in some cases even exceeded it. Given the economically backward nature of these countries (with the possible exception of Denmark and Sweden), we view these data problems as pointing to a more fundamental problem on the European periphery: how to enable short-term lending in the absence of sufficient bills of exchange (discount lending) or a scarcity of good collateral (conventional advances)?

In these seven cases, unsecured lending, lending against commodities (e.g., iron in the case of Sweden) and lending against real-estate played an important role. We have included all three categories as long as there was sufficient evidence that the lending was short-term.

**Comment on the relative sizes of time series ##4, 5**

*Exceptions to #4 >> #5*

Typically, there were many more bills of exchange than advances; a predominance captured in some languages even today when a central bank’s main lending rate is referred to as „discount rate“ (e.g., “Diskontsatz” in German). In the cases of Denmark, Norway, and Sweden, #4 remains larger than #5 even if we include marginal balance sheet items such as lending against iron (cf. our description of time series #5 above). The only exceptions are found in Bulgaria, Greece, Russia and Serbia. This dichotomy between the Balkans (and possibly Russia) on the one hand, and all other peripherals countries on the other hand, is consistent with recent interpretations that South-East Europe (and Russia) were particularly backward even when compared to other peripheral countries, resulting in the development of a distinctively different monetary system (Morys&Ivanonv 2015, Morys 2017).

## Table A1 Summary statistics

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | England | Austria | | Belgium | | | Germany | | France | | Netherlands | | Sweden |
| Share metalic reserves | 1 | 0,9169 | | 0,4974 | | | 1 | | 0,9986 | | 0,9079 | | 0,5849 |
| share foreign bills | 0 | 0,0593 | | 0,5026 | | | 0 | | 0,0014 | | 0,0921 | | 0,1317 |
| share foreign funds | 0 | 0,0238 | | 0 | | | 0 | | 0 | | 0 | | 0,2834 |
| share discount | 1 | 0,8737 | | 0,9095 | | | 0,8826 | | 0,6462 | | 0,4841 | | 0,6108 |
| share advances | 0 | 0,1263 | | 0,0905 | | | 0,1174 | | 0,3538 | | 0,5159 | | 0,3892 |
| discount rate | 3,7407 | 4,2963 | | 3,471 | | | 4,2572 | | 2,8833 | | 3,3768 | | 4,8714 |
|  | Denmark | | Norway | | Italy | Italy before 1903 | | Italy after 1902 | | Russia | | Russia before 1897 | | Russia after 1896 | Romania | |
| Share metalic reserves | 0,795 | | 0,6395 | | 0,8831 | 0,8787 | | 0,888 | | 0,9219 | | 0,9799 | | 0,9014 | 0,7792 |
| share foreign bills | 0,0607 | | 0,0506 | | 0,0749 | 0,0768 | | 0,0729 | | 0 | | 0 | | 0 | 0,2208 |
| share foreign funds | 0,1443 | | 0,3099 | | 0,042 | 0,0446 | | 0,0391 | | 0,0781 | | 0,0201 | | 0,0986 | 0 |
| share discount | 0,5528 | | 0,8552 | | 0,8589 | 0,8731 | | 0,8434 | | 0,5031 | | 0,5096 | | 0,5007 | 0,6858 |
| share advances | 0,4472 | | 0,1448 | | 0,1411 | 0,1269 | | 0,1566 | | 0,4969 | | 0,4904 | | 0,4993 | 0,3142 |
| discount rate | 4,6667 | | 5,0109 | | 4,596 | 4,7604 | | 4,4167 | | 5,163 | | 4,6042 | | 5,3603 | 5,5095 |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | Greece | Spain | Bulgaria | Portugal | Serbia | Japan | Finland |
| Share metalic reserves | 0,1553 | 0,9162 | 0,9012 | 1 | 0,9016 | 0,9025 | 0,5314 |
| share foreign bills | 0,8447 | 0,0478 | 0,0146 | 0 | 0 | 0,0975 | 0,0548 |
| share foreign funds | 0 | 0,036 | 0,0842 | 0 | 0,0984 | 0 | 0,4138 |
| share discount | 0,7244 | 0,7211 | 0,5477 | 0,7127 | 0,4346 | 0,3321 | 0,6423 |
| share advances | 0,2756 | 0,2789 | 0,4523 | 0,2873 | 0,5654 | 0,6679 | 0,3577 |
| discount rate | 6,3304 | 4,5688 | 7,4946 | 5,7355 | 7,0225 | 6,6989 | 5,1171 |

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# APPENDIX



*Figure A1a*: The reaction of central banks in core countries to a BoE discount rate shock using exchange rate percentage variation



*Figure A1b*: The reaction of central banks in peripheral countries to a BoE discount rate shock using exchange rate percentage variation



*Figure A1c*: The reaction of central banks in countries off the Gold Standard to a BoE discount rate shock using exchange rate percentage variation



*Figure A2*: The reaction of central banks in core countries to a BoE using open market rate



*Figure A3a*: The reaction of central banks in core countries to a BoE discount rate shock adding UK business cycle



*Figure A3b*: The reaction of central banks in peripheral countries to a BoE discount rate shock adding UK business cycle



*Figure A3c*: The reaction of central banks in countries off the Gold Standard to a BoE discount rate shock adding UK business cycle

1. Lindert (1969) was the first to follow Bloomfield by studying the role of foreign exchange interventions from 1900 to 1913. His work was also comparative and, as Bloomfield, he relied on annual data. Since then, scholars have confirmed Bloomfield’s results showing a negative correlation between the international and domestic assets of some individuals central banks: Drummond (1976) for Russia, McGouldrick (1984) for Germany, Dutton (1984) and Pippenger (1984) for England, Bazot et al. (2016) for France, Reis (2007) for Portugal before 1887, Jonung (1984) and Ogren (2012) for Sweden and Oksendal (2012) for Norway. They have also provided a detailed description of foreign exchange intervention in some countries (Reis (2007) and Esteves et al. (2009) for Portugal, Jobst (2009) for Austria-Hungaria, Ugolini (2012) for Belgium and Oksendal (2012) for Norway). [↑](#footnote-ref-1)
2. Bordo and Flandreau (2003) noticed that the level of financial development (measured as money over GDP) was positively associated with the probability to be on the gold standard. Our approach is different because we look at the differences within countries adhering to the gold standard. [↑](#footnote-ref-2)
3. The dataset includes 19 countries and 21 central banks because the Banks of Naples and Sicili are considered as separate entities. [↑](#footnote-ref-3)
4. A recent collection of statistics on historical central bank balance sheets (Ferguson et al. 2015) provides only annual data and broad categories for 12 central banks over the XXth century, with unsystematic distinction between foreign exchange and domestic assets. [↑](#footnote-ref-4)
5. Although Martin-Acena et al. (2012) claim that imperfect gold convertibility was the norm in the peripheral gold standard countries, we are only aware of White (1933), Contamin (2003), Reis (2007) and Bazot et al. (2016) which provide a detailed account of capital controls (gold premia) used by central banks. Bloomfield (1959) had already pointed out the role of premia on gold sales and other exchange controls (see p.58-59 on Russia for example: beyond 50,000 marks; foreign exchange was available to finance imports only). [↑](#footnote-ref-5)
6. Some comparative books on central banking written by economists or journalists during this period reproduced annual balance sheets but not the monthly or weekly ones. See for example Sumner et al. (1896), Lévy (1911), Conant (1915). [↑](#footnote-ref-6)
7. The interest in comparing central bank balance sheets can be tracked to a 1881 volume published by the Italian statistical institute. It was published in French. *Statistique International des banques d’émission: Autriche-Hongrie, Belgique, Pays-Bas, Suède, Norvège, Espagne,* Direzione Generale Della Statistica, Rome, Imprimerie Héritiers Botta. [↑](#footnote-ref-7)
8. Some data are available before 1891 for a limited number of central banks and several years are missing. See Archives of the Banque de France (ABF), 1377200101 /50. [↑](#footnote-ref-8)
9. It was then headed by Pierre Des Essars, who is mostly known to international historian for his wide ranging contribution to Sumner et a. (1896) on banking in European countries. Starting 1898, the unit “Statistique des banques étrangères” (Foreign Banking Statistics Service) changed its name to “Etudes économiques” (Economic studies). We thank Patrice Denis for this information. [↑](#footnote-ref-9)
10. The series of domestic commercial portfolios were also used ( at a annual frequency ) in the comparative book of Roulleau (1913) - the head of the research division of the Banque de France, and renown economist. Roulleau used such series as a proxy for domestic business cycles. He also provided a lot of institutional details on central banks. [↑](#footnote-ref-10)
11. Archives of the Banque de France (ABF), 1377200101/51-55. [↑](#footnote-ref-11)
12. Archives of the Banque de France (ABF), 1377200101/46-58. [↑](#footnote-ref-12)
13. The use of foreign bills by the Banque de France indeed started in 1906, with the exception of a swap with the Bank of England in 1890 during the Baring Crisis (Bazot et al. 2016). [↑](#footnote-ref-13)
14. The rationale for holding foreign exchange reserves was not limited to foreign exchange interventions. For profit maximizing central banks of the time, foreign bills could earn a higher return than metallic reserves (Lindert 1969). [↑](#footnote-ref-14)
15. Note that in order to account for all kind of advances against safe and liquid assets, advances on real estate’s short term assets have been included in series #5 for Denmark, Norway, and Sweden. Mortgage loans were excluded when they were long term loans financed by issuance of bonds rather than by money creation (Austria Hungaria, Greece, Bulgaria, Italy until 1894). In such cases, they are very stable. For a description of the use of advances on real estate by various central banks during this period, see, *Statistique International des banques d’émission: Autriche-Hongrie, Belgique, Pays-Bas, Suède, Norvège, Espagne,* Direzione Generale Della Statistica, Rome, Imprimerie Héritiers Botta, 1881. [↑](#footnote-ref-15)
16. Bloomfield was aware of the effect of the international cycle and considered the fact that there might be a negative correlation between international and domestic portfolios if the loans of the central bank varied counter-cyclically with the economy: “In some cases a more important explanation may lie in the fact that the international and domestic assets of central banks tended to move in opposite directions under the common influence of cyclical forces. In periods of business expansion, the domestic assets of all central banks tended naturally to rise, and in periods of contraction to fall. But as we have seen earlier, the international assets of various central banks tended to fall in periods of expansion and to rise in periods of contraction. In the case of these banks, then, we have another explanation for the tendency toward opposite annual movements in the two sets of assets.” Bloomfield (1959), p. 51. [↑](#footnote-ref-16)
17. Jorda et al. (2019) uses a similar identification, instrumenting domestic monetary policy shock with the BoE rate during the gold standard (and Fed rate thereafter). [↑](#footnote-ref-17)
18. As explained in Morys (2013), gold point violation was not infrequent over the considered period. [↑](#footnote-ref-18)
19. Fisher and IPS tests are particularly convenient as they can be performed despite unbalanced panel database. [↑](#footnote-ref-19)
20. A mint parity is proposed by the BdF source even if a country did not adhere to the Gold Standard. However, because the constraints of the Gold Standard were not binding for those countries, it might be more consistent to use the percentage variation in the exchange rate value in lieu of the deviation from mint parity. The results and conclusions remain the same with such alternative measure. See figure A1 in the appendix to this paper. [↑](#footnote-ref-20)
21. Note that the estimation does not add the bank of Napoli and Sicilia, though inclusion of those banks does not affect the results [↑](#footnote-ref-21)
22. The US Treasury also conducted some foreign exchange interventions (Bordo, Humpage and Schwartz 2015). [↑](#footnote-ref-22)
23. In order to be extend the comparison, we produce LP using open market rate instead of discount rate for core countries. The open market rate reacts three time less in core countries compared to the US. See figure A2 in the appendix to this paper. [↑](#footnote-ref-23)
24. As explained in Bazot et al. (2016), the money markets for which interest rates are recorded were premium markets. So, many financial institutions did not have access to this market and faced higher interest rates. Therefore, as the market rate increased, these institutions found more profitable to ask for the central bank discount window due to its unique national discount rate. In particular, central bank local branches were used as a privileged access to credit outside large financial centres (Jobst, 2010; Bazot, 2014). [↑](#footnote-ref-24)