OeNB
Oesterreichische Nationalbank
Eurosystem

Workshops

Proceedings of OeNB Workshops

The Experience of Exchange Rate Regimes in Southeastern Europe in a Historical and Comparative Perspective

Second Conference of the South-Eastern European Monetary History Network (SEEMHN)

April 13, 2007

No. 13

Adjustment under the Classical Gold Standard (1870s–1914): How Costly Did the External Constraint Come to the European Periphery?

Matthias Morys

University of Oxford

Abstract

Conventional wisdom has that peripheral economies had to “play by the rules of the game” under the Classical Gold Standard (1870s–1914), while core countries could get away with frequent violations. Drawing on the experience of three core economies (England, France, Germany) and seven peripheral economies (Austria-Hungary, Bulgaria, Greece, Italy, Norway, Serbia, Sweden), this paper argues for a more nuanced perspective on the European periphery. Our findings, based on a VAR model and impulse response functions, suggest that the average gold drain differed substantially across peripheral economies, with Austria-Hungary and Italy playing in a league with Germany and France rather than with the other peripheral economies. We also show that some of the peripheral economies, most notably Austria-Hungary, always enjoyed enough “pulling power” via discount rate policy to reverse quickly any such gold outflow. In sum, while the experience of some peripheral economies under gold was poor and hence normally short-lived, the experience of other peripheral countries resembled more those of the core economies.

Keywords: gold standard, balance-of-payment adjustment, central banking, rules of the game

JEL classification: E4, E5, E6, F3, N13

1. Introduction[1]

1.1 Historical Background: The Classical Gold Standard

The Classical Gold Standard (1870s–1914) has attracted the interest of economists ever since its foundation. The exchange rate stability – which was the result of countries tying their currencies domestically to gold – among most countries of the world for some forty years was unprecedented and remained an inspiration for policy-makers after the demise of the Classical Gold Standard at the outbreak of the First World War, leading to a short-lived resurrection in the interwar period and the Bretton Woods system of fixed exchange rates after the Second World War.

The literature on the Classical Gold Standard is vast and any categorisation necessarily involves some degree of simplification.[2] Despite this caveat, it can be said that research has focused on assessing the costs and benefits of adherence to gold. While benefits might be seen in easier and cheaper access to foreign capital[3], it is less straightforward to define the 'costs' of adhering to gold. The gold standard as a system of (quasi) fixed exchange rates required the monetary authority to adopt measures so that the exchange rate would follow mint parity[4] within the boundaries set by the gold points.[5] In other words, continuous adjustment efforts were needed to maintain the gold link. In the case of a gold outflow, the necessary

[1] I wish to thank all central banks of the South-Eastern European Monetary History Network (SEEMHN) for kindly providing the data needed for this paper. I also wish to thank Anders Oegren for advice regarding the Swedish data and generously sharing some of his data.

[2] Extensive bibliographies can be found in: B. Eichengreen and M. Flandreau, eds., *The Gold Standard in Theory and History*, 2nd ed. (London, New York: Routledge, 1997). M. D. Bordo and A. J. Schwartz, eds., *A Retrospective on the Classical Gold Standard. 1821–1931* (Chicago: University of Chicago Press, 1984).

[3] M. D. Bordo and H. Rockoff, The Gold Standard as a "Good Housekeeping Seal of Approval", *Journal of Economic History* 56 (1996).

[4] The "standard" exchange rate was determined by mint parity. For instance, the German gold standard legislation of 1871 stipulated that 2,790 marks would be coined out of 1 kilogram of refined gold; the corresponding Austro-Hungarian law of 1892 established that 3,280 crowns would be coined out of 1 kilogram of refined gold. This implies a mint ratio and, hence, a "standard" exchange rate of 1 mark = 3,280 / 2,790 crowns ≈ 1.1756 crowns.

[5] As a large proportion of transactions under the Classical Gold Standard were not settled by gold coins, but by bills of exchange drawn on foreign countries, the price of the bills of exchange – in short, the exchange rate – could fluctuate within certain boundaries that are known as the gold export point and the gold import point. These gold points reflect the fact that paying in specie incurred substantially higher transactions costs than settling with bills of exchange. Only if the exchange rate moved beyond the gold points, did it make sense to switch from using bills of exchange to using gold coins.

adjustment efforts would translate into raising the discount rate and/or reducing the monetary base – which is what Keynes famously called "playing by the rules of the game".[6] Both measures would typically reduce domestic economic activity. Thus, the gold standard carried with it the inherent policy conflict between external stability – i.e. to keep the exchange rate close to mint parity – and domestic stability. Negative repercussions of the necessary adjustment process on domestic economic activity can therefore be viewed as "costs" of the gold standard.

Conventional wisdom has that the adjustment process to balance of payments disequilibria was very different in the case of the "core countries" (UK, US, France, and Germany) as opposed to the "periphery".[7] Several studies have shown that the rich core countries could get away with frequent and sizeable violations of the "rules of the game".[8] By contrast, it is argued, peripheral countries had to play by the "rules of the game", thereby exposing themselves to negative repercussions on domestic economic activity. In other words, the conflict between external stability and internal stability is said to have been much more pronounced in the periphery than in the core. Different authors have emphasised different factors in explaining the alleged advantages of the core countries in the adjustment process. Essentially drawing on the theory of optimum currency areas, one school of thought has argued that core countries were simply better suited for monetary integration than the periphery.[9] Others have argued that central banks of core countries helped each other in times of crisis, but did not help peripheral economies for the lack of self-interest.[10] The more recent literature has stressed the importance

[6] K. W. Dam, *The Rules of the Game: Reform and Evolution in the International Monetary System* (Chicago: Chicago University Press, 1982).

[7] B. Eichengreen, *Globalizing Capital: A History of the International Monetary System* (Princeton: Princeton University Press, 1996).

[8] O. Jeanne, Monetary Policy in England 1893–1914: A Structural VAR Analysis, *Explorations in Economic History* 32 (1995). N. Davutyan and W. Parke, The Operations of the Bank of England, 1890–1908: A Dynamic Probit Approach, *Journal of Money, Credit and Banking* 27 (1995). A. Giovannini, "Rules of the Game" during the International Gold Standard: England and Germany, *Journal of International Money and Finance* 5 (1986). J. Dutton, The Bank of England and the Rules of the Game under the International Gold Standard: New Evidence, in: *A Retrospective on the Classical Gold Standard, 1821–1931*, eds. M. D. Bordo and A. J. Schwartz (Chicago: Chicago University Press, 1984). J. Pippenger, Bank of England Operations, 1893–1913, in: *A Retrospective on the Classical Gold Standard, 1821–1931*, eds. M. D. Bordo and A. J. Schwartz (Chicago: Chicago University Press, 1984).

[9] P. Martín Aceña and J. Reis, eds., *Monetary Standards in the Periphery: Paper, Silver, and Gold. 1854–1933* (London, New York: MacMillan Press, St. Martin's Press, 2000).

[10] B. Eichengreen, Central Bank Cooperation and Exchange Rate Commitments: the Classical and Interwar Gold Standards Compared, *Financial History Review* 2 (1995).

of credibility; Svensson[11], building on Krugman[12], has pointed out that a credible target zone can confer on a country a degree of independence in the operation of its monetary policy, even when the exchange rates are fixed. Applying this theoretical insight to economic history, the Classical Gold Standard has recently been interpreted as a target zone the limits of which were determined by the gold points.[13] Consequently, as long as economic agents view a country's commitment to gold as credible, such a country could violate the "rules of the game" in the short-run with a view to other policy goals.[14]

1.2 Hypothesis and Approach of this Paper

The literature hence portrays peripheral economies as disadvantaged in the pre-First World War monetary order. A closer examination of the literature, however, reveals that most studies rely on the core countries only. In the few cases where a specific country in the periphery was investigated on its own, the room for maneouvre in monetary matters turned out to be much larger than the stereotype wants us to believe.[15]

We challenge this view and argue for a more nuanced perspective on the European periphery. Our findings, based on a VAR model and impulse response functions, suggest that the average gold drain differed substantially across peripheral economies, with Austria-Hungary and Italy playing in a league with Germany and France rather than with the other peripheral economies. We also show that some of the peripheral economies, most notably Austria-Hungary, always enjoyed enough "pulling power" via discount rate policy to reverse quickly any such gold outflow. In sum, while the experience of some peripheral economies under gold was poor and hence normally short-lived, the experience of other peripheral countries resembled more those of the core economies.

England followed the gold standard from 1821 to the First World War without interruption. France and Germany joined in 1873 and adhered to gold until 1914.

---

[11] L. E. O. Svensson, Why Exchange Rate Bands? Monetary Independence In Spite of Fixed Exchange Rates, *Journal of Monetary Economics* 33 (1994).

[12] P. Krugman, Target Zones and Exchange Rate Dynamics, *Quarterly Journal of Economics* 56 (1991).

[13] Eichengreen and Flandreau, eds., *The Gold Standard in Theory and History*.

[14] C. P. Hallwood, R. MacDonald, and I. W. Marsh, Credibility and Fundamentals: Were the Classical and Interwar Gold Standards Well-Behaved Target Zones?, in: *Modern Perspectives on the Gold Standard*, eds. T. Bayoumi, B. Eichengreen, and M. P. Taylor (Cambridge: Cambridge University Press, 1996).

[15] M. Flandreau and J. Komlos, Core or Periphery? The Credibility of the Austro-Hungarian Currency, 1867–1913, in: *Auf Heller und Cent. Beiträge zur Finanz- und Währungsgeschichte*, eds. K. Bachinger and D. Stiefel (Frankfurt, Vienna: Ueberreuter, 2001).

Austria-Hungary, Italy, Sweden and Norway followed the Classical Gold Standard for different periods. Austria-Hungary passed gold standard legislation in 1892, but exchange-rate stability to other gold standard countries was achieved only in 1896; the gold link was then maintained until the outbreak of the First World War.[16] Italy enacted gold convertibility in 1883, but was forced to suspend specie payment – i.e. conversion of bank notes into gold by the central bank – again in 1891. Mint parity was achieved again in 1903 and maintained until the outbreak of the First World War.[17] When estimating Italy, we will therefore differentiate between Italy's earlier adherence to gold (1883 – 1891) and its later adherence (1903–1913); we will the two periods Italy 1 and Italy 2, respectively. The Swedish and the Norwegian cases are less complicated. Both countries followed the Classical Gold Standard from 1873 until the outbreak of the First World War.

The exchange rate experience of the Balkan countries before the First World War has so far been largely unknown, but the South-Eastern European Monetary History Network has produced first results on which this paper can draw (cf. the appendix to these conference proceedings). The exchange-rate performance suggests to classify Bulgaria, Greece, and Serbia as on gold from 1/1906–9/1912, 1/1910–7/1914 and 7/1905–9/1912, respectively.

The estimation period is occasionally slightly more restricted due to data availability. Table 1 summarizes the periods of adherence to gold and the estimation periods.

[16] Ibid., pp. 163–169. J. Wysocki, Die österreichisch-ungarische Krone im Goldwährungsmechanismus, in: *Geld und Währung vom 16. Jahrhundert bis zur Gegenwart*, ed. E. Schremmer (Stuttgart: Franz Steiner Verlag, 1993), pp. 143–150.

[17] M. Fratianni and F. Spinelli, Italy in the Gold Standard Period, 1861–1914, in: *A Retrospective on the Classical Gold Standard, 1821–1931*, eds. M. D. Bordo and A. J. Schwartz (Chicago: University of Chicago Press, 1984), pp. 408–417. G. Tattara, Was Italy Ever on Gold?, in: *Monetary Standards in the Periphery: Paper, Silver, and Gold, 1854–1933*, eds. P. Martín Acena and J. Reis (London, New York: MacMillan Press, St. Martin's Press, 2000), pp. 19–30.

Table 1: Countries Studied in this Paper

	Adherence to gold	Estimation period
Austria-Hungary	1896–1914	1/1896–12/1913
Bulgaria	1906–1912	1/1906– 9/1912
UK	1821–1914	11/1875– 6/1914
France	1873–1914	1/1889–12/1913
Germany	1873–1914	11/1875– 7/1914
Greece	1910–1914	1/1910– 6/1914
Italy I	1883– 1891	1/1883– 12/1891
Italy II	1903–1914	1/1903– 12/1913
Norway	1873–1914	1/1873–7/1914
Serbia	1905–1912	7/1905–9/1912
Sweden	1873–1914	1/1878–12/1913

Source: Cf. main text.

The remainder of this paper is organised as follows. In the second section, we will describe adjustment under the Classical Gold Standard from a theoretical perspective. This will help clarify the importance we attach to the discount rate and the monetary base in our empirical work. We will then describe the data employed (3rd section). The fourth section is devoted to the econometric estimation and the fifth section to the empirical results. Section 6 summarises and concludes.

2. Adjustment under the Classical Gold Standard

In this section we will describe adjustment under the Classical Gold Standard from a theoretical perspective. This will help clarify the importance we attach to the bank rate and the monetary base in our econometric estimation in sections 4 and 5. These two time series, coupled with the gold reserves, are the only time series being employed in this paper. In what follows, we will argue that estimating how costly the external constraint came to the European periphery can be based on these three time series alone.

Under a system, fixed exchange rates such as the Classical Gold Standard, balance of payments adjustment can principally occur through two channels[18]: (a) via the so-called price-specie flow mechanism, and (b) via short-term capital flows. Adjustment can be accelerated by appropriate central bank behaviour, with the adjustment via the price-specie flow mechanism giving rise to the non-sterilisation-rule and the adjustment via short-term capital flows giving rise to the discount-rate-rule. As an understanding of both forms of adjustment is required for the set-up of our econometric model (and in particular the impulse-response functions), we need to explain them in some detail.

2.1 Hume's Price-specie Flow Mechanism

The Scottish philosopher and economist David Hume (1711–1776) was the first person to reflect on how adjustment would take place under a specie standard such as the gold standard. In his "Of the Balance of Trade" (1752), Hume considers two economies operating a gold coin standard, i.e. gold coins circulate among economic agents in each country, and bank notes are unknown. Another feature of the Humean model is that there is only goods arbitrage available, but no capital arbitrage. Under such a scenario, metallic flows would increase the money supply of the country to which the metal went, and reduce the money supply of the country from which the metal came. Based on the quantity theory of money, the increased money supply would lead to higher prices in one country, while the decreased money supply would lead to lower prices in the other. The resulting price difference would give a comparative edge to the country that had lost metal in the first place, thus strengthening the balance of trade and, once again, leading to external equilibrium. For Hume, arbitrage in the goods market, because of price differentials, would cause adjustment.[19]

The key question in our context is how we can operate the price-specie flow mechanism under the conditions of the pre-First World War gold standard. Hume described the gold coin standard as a standard where only gold coin circulated among economic agents and where there was no monetary authority. Both these features changed over the course of the 19th century. The gold coin standard became the gold bullion standard[20]; gold coin was still in circulation in most of the countries adhering to the gold standard, but the bulk of the monetary base came to

[18] M. D. Bordo, The Gold Standard: The traditional approach, in: *A Retrospective on the Classical Gold Standard, 1821–1931*, eds. M. D. Bordo and A. J. Schwartz (Chicago: University of Chicago Press, 1984). Editors' introduction to Eichengreen and Flandreau, eds., *The Gold Standard in Theory and History*, pp. 12–19.

[19] D. Begg, S. Fischer, and R. Dornbusch, *Economics*, 6th ed. (London: McGraw-Hill, 2000), p. 574.

[20] R. Nurkse, *International Currency Experience. Lessons of the Interwar Period*, ed. League of Nations (Princeton: 1944), p. 66.

consist of bank notes. Bank notes were convertible against the gold coin and/or gold bullion at the central bank. We have to ask ourselves how the Humean adjustment process would look within the framework of the late 19th century central bank administered gold bullion standard.

From an economic point of view, however, there is little difference between the 18th century gold coin standard and the 19th century gold bullion standard: „Under any form of gold standard, gold is used for the settlement of discrepancies in the balance of payments. Under the "gold specie standard," where the domestic circulation as well as the international means of settlement consisted largely of gold, the relationship between the domestic money supply and the balance of payments was direct and immediate; in fact, the very distinction between national and international currency became important only with the growing use of bank notes and deposits in circulation. Under the "gold bullion standard,", where bank notes and deposits formed the great bulk of domestic money, the relationship was less obvious but still generally operative, since any purchase of gold by the central bank could normally be expected to increase a country's note circulation and bank deposits while any outflow of gold usually decreased them."[21]

We conclude as follows: Hume's price specie flow model can be operated by a comparison of the effects of a gold outflow on the monetary base. Under late 19th century conditions, the monetary base essentially consisted of bank notes in circulation (cf. section 3). If we witness a one-to-one relationship – i.e. if a gold flow of one unit translates into a one unit change in the monetary base – , then the central bank would help the balance of payments adjustment mechanism by not sterilizing gold flows. This rule became known as the non-sterilization-rule in the gold standard literature.[22] By contrast, if we witness less than a one-to-one relationship – i.e. if a gold flow of one unit translates into less than a one unit change in monetary base – , the monetary authority embarked on sterilisation policies. It is generally thought that sterilisation policies are followed in order to soften the impact of a currency peg on the domestic economy. Impulse response functions allow us to estimate the impact of a gold flow on the monetary base.

2.2 Adjustment via Short-term Capital Flows

Hume's price-specie flow mechanism was the first systematic attempt to explain the adjustment mechanism under a specie-standard. With time, economists became increasingly aware that adjustment via the goods market was not the only and perhaps not even the most important channel of adjustment. Any adjustment via price level differences is necessarily slow, while adjustment in the capital market

[21] Ibid.

[22] Dam, *The Rules of the Game: Reform and Evolution in the International Monetary System*.

tends to be much quicker. Increased financial integration in the 19th century brought the adjustment via short-term capital flows to centre-stage.[23] In modern economics, epitomised by the still influential Mundell-Fleming open-economy models, it is usually adjustment via short-term capital flows that is seen as crucial in balance of payments adjustment.

Thus, if a central bank wants to accelerate the adjustment process, we would expect a gold outflow to be followed by an increase of the bank rate. This rationale became known as the bankrate-rule in the gold standard literature.[24] Conversely, if a central bank attributed more importance to domestic policy goals, a central bank might leave the bank rate unchanged despite reserve drains. Again, a VAR model with impulse response functions will allow us to establish whether a central bank followed the bankrate-rule by estimating the impact of a gold flow on the bankrate.

2.3 The "Rules of the Game" Concept

The existence of these two main forms of adjustment, coupled with the 19th century belief that the central bank was responsible for maintaining the peg, culminated in the concept of the "rules of the game": central banks were supposed to react to a gold outflow by two means: (1) raising the discount rate, and (2) reducing the monetary base.

The preceding description of the balance of payments adjustment mechanism has demonstrated that three time series are of crucial importance when determining whether a central bank played by the "rules of the game" or not: (1) the gold reserves, (2) the monetary base, and (3) the bank rate. The non-sterilisation-rule can be operated by establishing whether a one-unit gold outflow led to a monetary base reduction of similar size. The bankrate-rule can be verified by investigating whether the central bank reacted to a gold outflow by raising the bankrate.

In what follows, we want to focus solely on the relationship between gold reserves and bank rate. This focus is partly due to space constraints of this paper, but it could be justified on the grounds that 19th century observers felt that the bank rate was much more important than the monetary base in the gold standard adjustment mechanism.

3. Data Employed in this Paper

We will describe the Austro-Hungarian and the Italian data in some detail and confine ourselves to some remarks regarding the other countries due to space constraints.

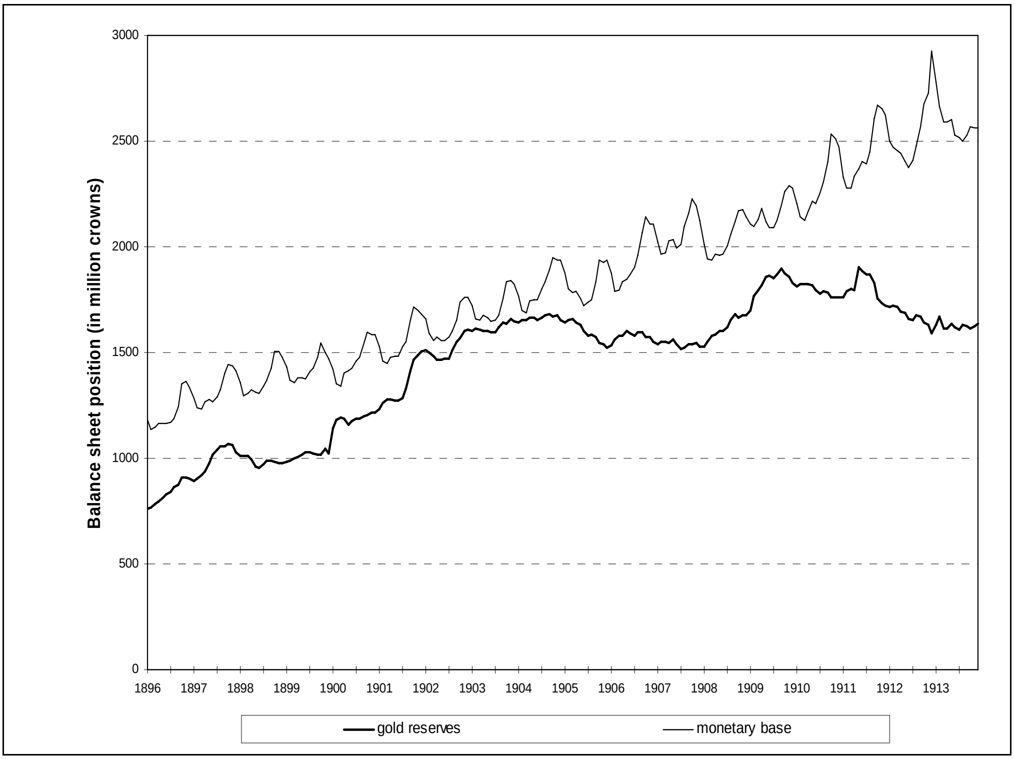
[23] Bordo, The Gold Standard: The Traditional Approach.

[24] Dam, *The Rules of the Game: Reform and Evolution in the International Monetary System*.

Austria-Hungary

Estimation was carried out for the years 1896 to 1913 (table 1). Chart 1 shows the Austro-Hungarian raw data for gold reserves and monetary base.

Chart 1: Austria-Hungary: Gold Reserves and Monetary Base, 1896–1913



Source: Cf. data description in the main text.

a. Gold Reserves

Monthly data of the gold reserves were published in the annual reports of the Austro-Hungarian bank.[25] Reserves consist of (1) gold bullion and gold coin, (2) silver coin, (3) gold bills, i.e. bills of exchange drawn on places located in gold standard countries ("Goldwechsel auf auswärtige Plätze"), (4) deposits on foreign banks, and (5) foreign bank notes.

b. Monetary Base

The monetary base is the primary stock of money in an economy.[26] As opposed to bank-created deposit money, the monetary base is the part of the money supply under the (almost) exclusive control of the monetary authority. This explains the economists' interest in the monetary base when trying to establish a central bank's policy. The monetary base essentially[27] encompasses all liquid liabilities of the monetary authority. Under pre-1914 conditions, liquid liabilities were first and foremost the banknotes (ca. 90%), followed by commercial banks' deposits at the central bank. Data were taken from the annual reports of the Austro-Hungarian bank.

c. Bankrate

Bank rates were taken from the *Compass*[28], the leading financial yearbook in the dual monarchy.

---

[25] Appendix 2 (Übersicht der Geschäftsbewegung) of Jahressitzung der Generalversammlung der Österreichisch-ungarischen Bank, 1 (1879)–36 (1914), Vienna.

[26] F. H. Capie and A. Webber, *A Monetary History of the United Kingdom. 1870–1982. Volume 1. Data, Sources, and Methods* (London, New York: Routledge, 1995), p. 9.

[27] Opinion differs as to whether coins should be counted as part of the monetary base. The question has both a theoretical and a practical dimension. On a theoretical level, two schools of thought can be distinguished: If the notion of "monetary base" is derived from the process of money creation, coins should clearly be included (cf. Begg, Fischer, and Dornbusch, *Economics*, pp. 375–385.). By contrast, if the notion of "monetary base" is developed behind the background of what a central bank can control, coins should not be included as they do not constitute the liability of a central bank (but of the treasury); accordingly, the European Central Bank does not consider coins part of the monetary base (cf. F. Kissmer, *Die Geldpolitik in der Europäischen Währungsunion* (Hagen: 2004), p. 109.). On a practical level, it is impossible to establish a time series for coin in circulation for Austria-Hungary at the frequency we are aiming for. Omitting coins, however, is unlikely to introduce any bias due the small size as opposed to the other two components of the monetary base; moreover, coin in circulation was certainly less volatile than the other two components.

[28] *Compass. Finanzielles Jahrbuch für Österreich-Ungarn*, 48 (1915), p. 151.

Italy

a. Gold Reserves

Monthly data of the gold reserves have been collected by R. de Mattia in his 1967 data collection on the Italian banks of note issue.[29] De Mattia has a very broad definition of reserves, and we felt the need not to include all of them into our study. In particular, de Mattia includes bonds of the Italian state or guaranted by the Italian state among reserves. For the purpose of this study, it seemed more appropriate to include only holdings of gold (## 1, 4, 6), silver (## 2, 3, 5), and foreign exchange (#13).

b. Monetary Base

Monthly data of the note issue can be found in the same statistical reference work.[30] We could not find data for commercial banks' deposits at the bank of note issue. In the case of Austria-Hungary, we included them as they do technically constitute part of the monetary base. At the same time, they account for less than 10% of the monetary base in the case of Austria-Hungary. De Mattia's 1967 collection of data, carried out under the auspices of the Bank of Italy, is of high quality and remains the standard source. As he does not provide such data, he himself was most likely either unable to establish such numbers, or, alternatively, the numbers he found were of negligible size which is why he did not include them. Either way, our time series for the monetary base consists entirely of bank notes in circulation.

c. Bankrate Differential

Monthly data of the Italian bankrate can also be found in de Mattia 1967.[31]

Bulgaria

Data were kindly communicated by the Balgarska Narodna Banka.

United Kingdom

Data were taken from Capie&Webber (1995). Discount rate data were taken from Hawtrey (1962).

---

[29] R. de Mattia, *I bilanci degli istituti di emissione italiani dal 1845 al 1936, altre serie storiche di interesse monetario e fonti*, vol. 2, *Banca d'Italia: Studi e ricerche sulla moneta* (Rome: 1967), table 19, pp. 619–753.
[30] Ibid., table 5 (column 1 only), pp. 446–454.
[31] Ibid., table 20, pp. 812–815.

France

Data were taken from the Annual Reports of the Banque de France, 1890–1914. Discount rate data were taken from Hawtrey (1962).

Germany

Data were taken from the "Verwaltungsberichte der Reichsbank", 1876–1914.

Greece

Data were kindly communicated by the Central Bank of Greece.

Norway

Data were downloaded from www.norksebank.org

Serbia

Data were kindly communicated by the Central Bank of Serbia.

Sweden

a. Gold Reserves

Monthly data of the gold reserves were published in the "Sammandrag af Bankernas Uppgifter" (Summary of Bank Reports) which were published at the end of each month.[32]

b. Monetary Base

As in the case of Italy, no information could be found on commercial banks' deposits at the bank of note issue. We have therefore only relied on the amount of bank notes in circulation, which were taken from the same source as the gold reserves.[33]

[32] Sammandrag af Bankernas Uppgifter , 1878 – 1900, Stockholm.
[33] In practical terms, we are grateful to Anders Oegren for generously sharing the monetary base data which he had already collected from the sources mentioned above.

c. Bankrate Differential

Monthly data of the Swedish bankrate can be found in an offical publication of the Swedish Riksbank.[34]

4. Estimation

The choice of the appropriate econometric model is largely determined by the nature of the problem under investigation. As the discussion on the "rules of the game" in section 2 has demonstrated, the monetary authority was supposed to react to gold outflows by raising the discount rate and/or reducing the monetary base. Consequently, three time-series are important: gold reserves, monetary base, and the bank rate. It also seems appropriate to take–as an exogenous variable–the bank rates of the core countries (England, France, and Germany) into account.

Which of the three variables–gold reserves, monetary base or bank rate–can be treated as exogenous? Not the monetary base and the bank rate, for we are interested in how these two variables react to changes in gold reserves. This rationale implies that monetary base and bank rate differential are endogenous variables. The same is true for the gold reserves; a discount rate increase and/or a reduction of the monetary base aim at increasing gold holdings at the central bank. Thus, all three variables need to be treated as endogenous.

This rationale favours a vector autoregression approach (VAR). As the terminology suggests, a vector–rather than a scalar–is explained by its past values. As a VAR requires stationary time series, we tested for stationarity with the help of an ADF-test. Table 2 shows that gold reserves and monetary base show up as I(1) in most cases. Only the interest rate time series come out usually as I(0), even though there are some outliers even here (Bulgaria, France, Serbia).[35]

[34] Sveriges Riksbank, *Sveriges Riksbank 1668–1924–1931* (Stockholm: 1931), v. 5, pp. 136–138.

[35] Bulgaria, France and Serbia are, incidentally, countries with relatively infrequent discount rate changes. As a result, the time series appear to have mean shifts which can give the appearance of I(1) non-stationarity.

Table 2: Results of Augmented Dickey-Fuller Tests

		Time series: levels						Time series: first differences	
		ADF test with intercept	Levels at which H_0 of unit root cannot be rejected	ADF test with intercept and linear trend	Levels at which H_0 of unit root cannot be rejected	F-value to test H_0: $\beta = \Phi^* = 0$	Levels at which H_0 cannot be rejected	ADF test with intercept	Level at which H_0 of unit root can be rejected
Austria-Hungary	gold	–2.5316	10% 5% 1%	–1.3468	10% 5% 1%	3.1890	10% 5% 1%	–9.5564	1%
	mb	–1.2418	10% 5% 1%	–3.7628	10% 5% 1%	7.4445	1%	–10.6127	1%
	i	–2.2268	10% 5% 1%						
Bulgaria	gold	–0.3384	10% 5% 1%	–1.8400	10% 5% 1%	1.8346	10% 5% 1%	–7.3835	1%
	mb	0.1226	10% 5% 1%	–1.9368	10% 5% 1%	2.2750	10% 5% 1%	–8.6669	1%
	i	–0.3007	10% 5% 1%						
UK	gold	–2.5566	10% 5% 1%	–4.7310		11.193		–18.502	1%
	mb	–1.5007	10% 5% 1%	–3.7891	1%	7.1793	1%	–20.341	1%
	i	–7.6280							
France	gold	–1.4664	10% 5% 1%	–2.4895	10% 5% 1%	3.2797	10% 5% 1%	–12.120	1%
	mb	–0.0249	10% 5% 1%	–5.2680		13.929		–12.926	1%
	i	–1.1877	10% 5% 1%						
Germany	gold	–1.3983	10% 5% 1%	–3.5105	1%	6.1884	5% 1%	–9.0526	1%
	mb	1.2995	10% 5% 1%	–1.0917	10% 5% 1%	1.6050	10% 5% 1%	–16.803	1%
	i	–3.4304	1%						
Greece	gold	–1.4581	10% 5% 1%	–1.3465	10% 5% 1%	1.6347	10% 5% 1%	–8.4747	1%
	mb	–0.5487	10% 5% 1%	–1.8068	10% 5% 1%	1.6347	10% 5% 1%	–4.2483	1%
	i	not applicable, as discount rate did not change							
Italy I	gold	–1.5472	10% 5% 1%	–2.9379	10% 5% 1%	4.3254	10% 5% 1%	–3.6709	1%
	mb	–1.8064	10% 5% 1%	–1.3512	10% 5% 1%	7.2019	1%	–11.5492	1%
	i	–2.3143	10% 5% 1%						
Italy II	gold	–2.3383	10% 5% 1%	–0.7565	10% 5% 1%	2.7159	10% 5% 1%	–6.8551	1%
	mb	–2.1076	10% 5% 1%	–0.6952	10% 5% 1%	2.2032	10% 5% 1%	–7.5268	1%
	i	–2.4031	10% 5% 1%						
Norway	gold	–0.4211	10% 5% 1%	–3.3736	5% 1%	6.3037	1%	–17.900	1%
	mb	1.2299	10% 5% 1%	–2.2572	10% 5% 1%	5.0235	10% 5% 1%	–21.655	1%
	i	–3.3274	1%						
Serbia	gold	0.9480	10% 5% 1%	–1.8530	10% 5% 1%	3.4576	10% 5% 1%	–6.9708	1%
	mb	–0.1148	10% 5% 1%	–2.9354	10% 5% 1%	4.5855	10% 5% 1%	–5.9787	1%
	i	–1.7275	10% 5% 1%						
Sweden	gold	–0.6778	10% 5% 1%	–2.9955	10% 5% 1%	4.5116	10% 5% 1%	–20.856	1%
	mb	0.2875	10% 5% 1%	–1.0408	10% 5% 1%	0.7593	10% 5% 1%	–18.522	1%
	i	–3.1227	1%						

Source: Author's calculations based on data as discussed in the main text.

The presence of I(1) time series raises the prospect of a vector error correction model (VEC model). A VEC model relies on I(1) time series that are related to each other by a so-called cointegrating relationship.[36] A cointegrating relationship is a long-run relationship between different variables; this long-run relationship might be violated in the short-run, but forces inherent to the system will correct any such deviation in the long run. From an economic point of view, a system exhibiting such dynamics is an equilibrium: violations in the short-run may occur, but equilibrium will restore itself after some time.

This description fits the economic relationship between gold reserves and monetary base, which happen to be the two time series that show up as I(1) in most cases in table 2. In the long-run, the monetary base needs to be backed up by a certain amount of gold reserves.

For this reason we have tested for a cointegrating relationship between gold reserves and monetary base. Two test statistics are available for the Johansen cointegration rank test, which is the most commonly used cointegration test: the trace statistic and the Max-Eigenvalue statistic. Two tests were carried out in each case, depending on the specific nature of the underlying time series (trend-stationary time series versus difference-stationary time series, cf. columns 7 and 8 in table 2). This makes for 4 different statistics in the case of each country (table 3).

Table 3 shows that in some cases (England, Germany, Norway, Sweden), a cointegrating relationship is warranted under all four assumptions. In other cases (Greece, Serbia), by contrast, all four test statistics suggest the absence of a cointegrating relationship. In the remaining cases, some test statistics suggest cointegrating relationships, while others do not. Mixed results are not unusual in cointegration analysis, and conflicting results are often settled with the help of economic theory: if there is enough reason to believe in an underlying relationship, cointegration analysis is often applied even if some of the statistics do not suggest the presence of a cointegrating relationship.

In our case, however, we have to bear in mind that for some countries none of the four test statistics suggest such a cointegrating relationship. We therefore decided against using a VEC model and to stick to the more conventional VAR approach.

---

[36] W. Enders, *Applied Econometric Time Series*, 2nd ed. (New York: 2004), pp. 320–373. J. Johnston and J. DiNardo, *Econometric Methods*, 4th ed. (New York: 1997), pp. 301–305.

Table 3: Results of Johansen Cointegration Rank Test

	Trace statistic			Max-Eigenvalue statistic		
	Trace statistic	5% critical value	Cointegrating relationship implied	Max-Eigen value statistic	5% critical value	Cointegrating relationship implied
Austria-Hungary	24.85	20.26	+	19.31	15.89	+
	13.87	15.49	–	10.22	14.26	–
Bulgaria	25.18	20.26	+	19.20	15.89	+
	6.35	15.49	–	6.33	14.26	–
UK	21.98	20.26	+	19.15	15.89	+
	20.88	15.49	+	19.00	14.26	+
France	22.61	20.26	+	13.55	15.89	–
	10.93	15.49	–	10.67	14.26	–
Germany	34.34	20.26	+	23.66	15.89	+
	23.89	15.49	+	23.23	14.26	+
Greece	16.88	20.26	–	11.00	15.89	–
	8.14	15.49	–	5.94	14.26	–
Italy I	26.87	20.26	+	18.72	15.89	+
	20.37	15.49	+	12.77	14.26	–
Italy II	43.20	20.26	+	28.59	15.89	+
	24.86	15.49	+	20.50	14.26	+
Norway	21.62	20.26	+	17.78	15.89	+
	18.30	15.49	+	16.95	14.26	+
Serbia	7.12	20.26	–	5.38	15.89	–
	2.99	15.49	–	2.92	14.26	–
Sweden	53.44	20.26	+	46.45	15.89	+
	30.79	15.49	+	30.79	14.26	+

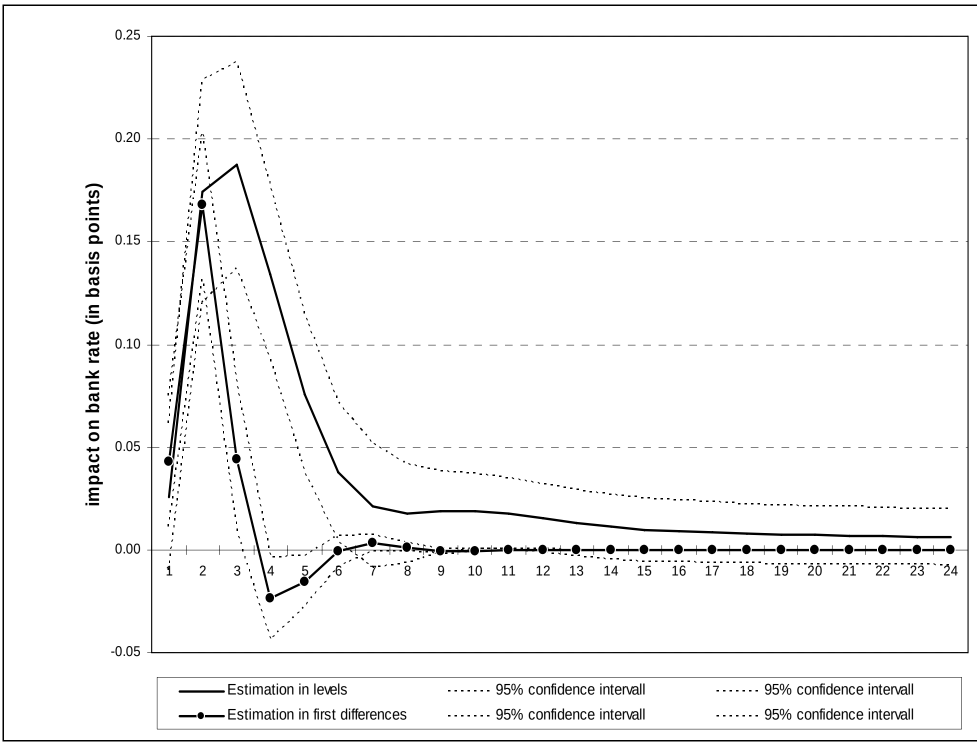
Source: Author's calculations based on data as discussed in the main text.

Returning to the results of the ADF–tests (table 2), we are confronted with a situation in which some time series are I(1) while others are I(0). Advice is conflicting in such situations: While some authors suggest estimating in first differences, others prefer running the VAR in levels despite some of the time series showing up as non-stationary.[37] We have tried out both options and found that, in most cases, results were surprisingly similar. Chart 2 shows, for instance, an impulse response function of the English bank rate, estimated both in levels and in first differences. While the overall shape and magnitude of the impulse response

[37] Cf. Enders, *Applied Econometric Time Series*, 264–310.

functions tended to be very similar in most cases, the main difference was probably that impulse response functions in differences returned quicker to 0 (as one would expect). In the following, we have calculated all VARs in levels rather than in first differences.

Chart 2: Comparison of VAR Estimation in Levels and in First Differences, Illustrated by the Response of the English Bank Rate to a (Negative) One-Standard Deviation Gold Shock (Cholesky-Decomposition)



Source: Author's calculations based on data as discussed in the main text.

As VAR estimations are widespread these days, there is no need to explain this technique in detail. Only two issues need to be addressed in this context: (a) the construction of the exogenous variable, i.e. the bank rate of the core countries (England, France, Germany); (b) the lag length of the VARs.

As for the exogenous variable, there was obviously the need to introduce some kind of "global" bank rate. As a matter of fact, the bank rate differential rather than the bank rate itself determines the "pulling power" of a given country. We experimented with a number of options, but finally chose to adopt the arithmetic average between the discount rates in London, Paris and Berlin. The reader may rest assured that the other options we tried out led to very similar results. In the case of England, France, and Germany, the exogenous discount rate only included the other two countries.

The appropriate lag length of each VAR model was determined by the standard lag length criteria.[38] The most commonly used information criteria in this context– the sequential modified LR test statistic (LR), the final prediction error (FPE), the Akaike information criterion (AIC), the Schwartz criterion (SC) and the Hannan-Quinn criterion (HQ)–often suggested the same lag length, most usually one or two lags. If the information criteria suggested different lag lengths, we chose the Schwartz criterion over the others criteria for it most usually leads to shorter lag lengths.

5. Results

Space constraints prevent us from reporting the VAR estimates, but the rich interactions between the variables in the case of vector regressions (as opposed to scalar regressions) would inhibit us from attaching a straightforward interpretation to the given numbers anyway. The best way to interpret the results of a VAR model is to calculate the impulse response functions. Impulse response functions trace out how the different variables react in periods 1, 2, 3, … n to a specific shock to one of the variables in period 1. Similar to a natural science experiment in a laboratory, one specific cause and its effects can be isolated and studied on their own. This is precisely what we are interested in our case: How does the bank rate respond in periods 1, 2, 3, … n to a sudden gold outflow in period 1? Vice versa, it is also interesting to see how much gold a given country can attract with a 1% increase of the bank rate.

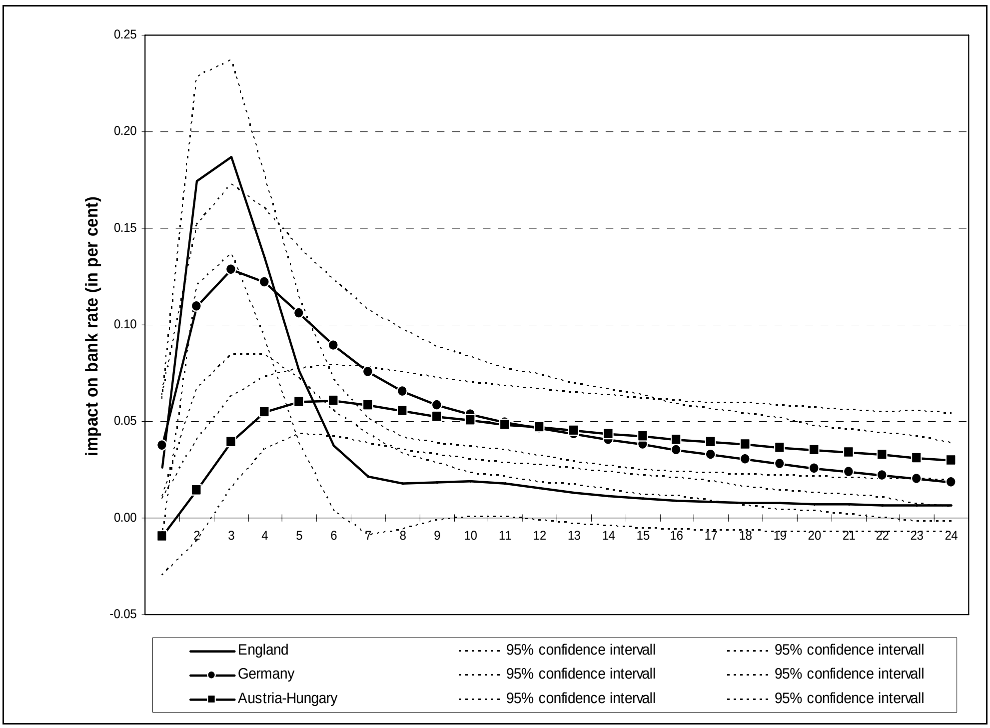
In other words, impulse response functions can be used to assess how difficult it was for a given country to maintain the gold link. As already indicated, two types of question are the most relevant in this context. First, how does the bank rate respond to a sudden gold outflow? If country A needed to react much stronger than country B, then we could argue that adherence to A came more costly than to B. If confronted with a gold outflow, it would then be important to determine the "pulling power" of country A as opposed to country B: If country A raises its discount rate by one percentage point, how many reserves will it attract? Will it attract more or less than country B?

Let us turn to the first question. Chart 3 shows the response of the English, German and Austro-Hungarian bank rates to a (negative) one-standard deviation

[38] Ibid., p. 363.

gold shock (based on the Cholesky-decomposition with the Cholesky ordering: gold reserves → interest rate → monetary base). Interestingly enough, we see that the English discount rate actually responds much stronger to a gold outflow than the German discount rate, and the German discount rate reacts stronger than the Austro-Hungarian discount rate; which is certainly the opposite of what we expect.

Chart 3: Response of English, German and Austro-Hungarian Bank Rates to a (Negative) One-standard Deviation Gold Shock (Cholesky-Decomposition)



Source: Author's calculations based on data as discussed in the main text.

We have to take into account, however, that the bank rate reacts to an "average gold shock" (i.e., a one-standard deviation gold shock in the words of the VAR terminology) which may obviously be very different from country to country. In other words, we need to establish the exact size of the average shock in each country; this piece of information can also be inferred from the VAR estimate. Table 4 shows the average size of the gold shocks and scales them by the amount of reserves available to a specific central bank.

Table 4: Number of Discount Rate Changes and Size of Average Gold Shock

	Total number of discount rate changes during estimation period	*Discount rate changes per year during estimation period*	*Average size of gold shock, relative to average reserve level*
Austria-Hungary	27	1.5	0.17%
Bulgaria	2	0.3	0.86%
England	226	5.8	2.38%
France	19	0.8	0.13%
Germany	137	3.6	0.40%
Greece	0	0.0	not applicable
Italy I	11	1.2	0.44%
Italy II	40	3.6	0.14%
Norway	83	2.0	0.88%
Serbia	4	0.6	1.50%
Sweden	65	1.8	1.48%

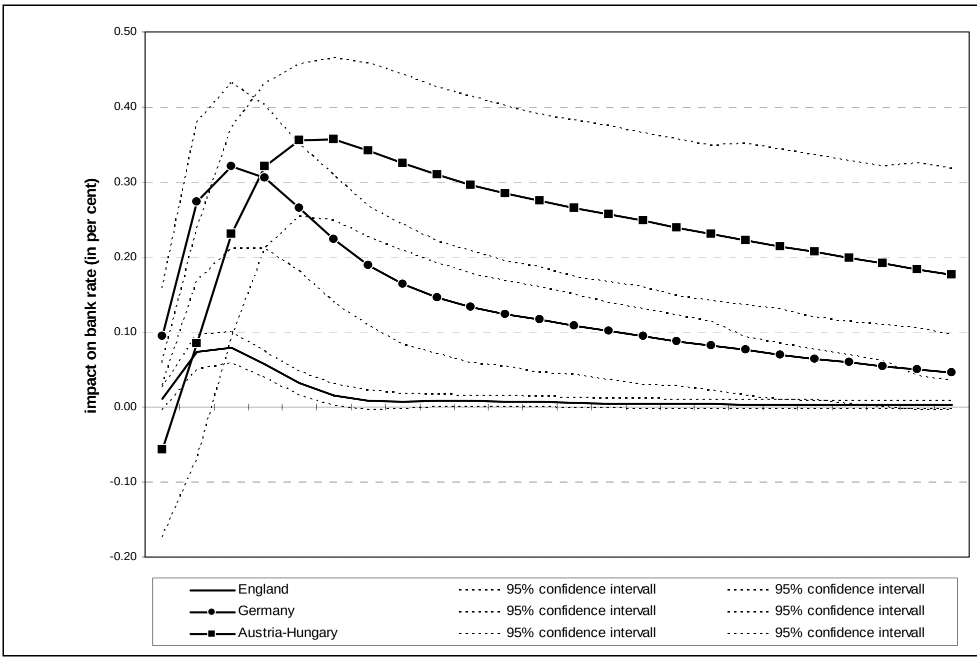
Source: Author's calculations based on sources as discussed in the main text.

Table 4 is most illuminating in our context. In the English case, for instance, an average gold flow takes the size of 2.38% of the gold reserves of the Bank of England. By contrast, an average German shock is only 0.40% and an average shock to Austria-Hungary is even smaller (0.17%), compared to their reserves.

What explains these differences, and how important are they in assessing chart 3? If we abstract from the English case for the moment, a certain pattern emerges when we try to rank countries by the size of the average shock. Serbia, Sweden, Norway and Bulgaria were all truly peripheral economies in the pre-First World War setting; they all enjoyed substantially higher average shocks than Germany, France, Austria-Hungary and Italy. Thus, a case could be made that, *cum grano salis*, the more peripheral an economy, the higher the average shock. But what then explains that England was exposed to even higher average shocks? We admit that no easy answer is available to this question, but it might well have to do with London as the single most important financial centre and the most important money market before the First World War. As a consequence, shocks were higher than anywhere else, as money could more easily be moved in and out of the country.

In chart 4 we have computed the response of the English, German and Austro-Hungarian bank rates to a (negative) gold shock of one percent compared to reserve levels. In other words, as opposed to chart 3, we control here for the size of the average shock. Chart 4 is much more in accordance with our expectations: London performs “best”, followed by Berlin and Vienna. Still, it is worth noting that there is little difference between Berlin and Vienna.

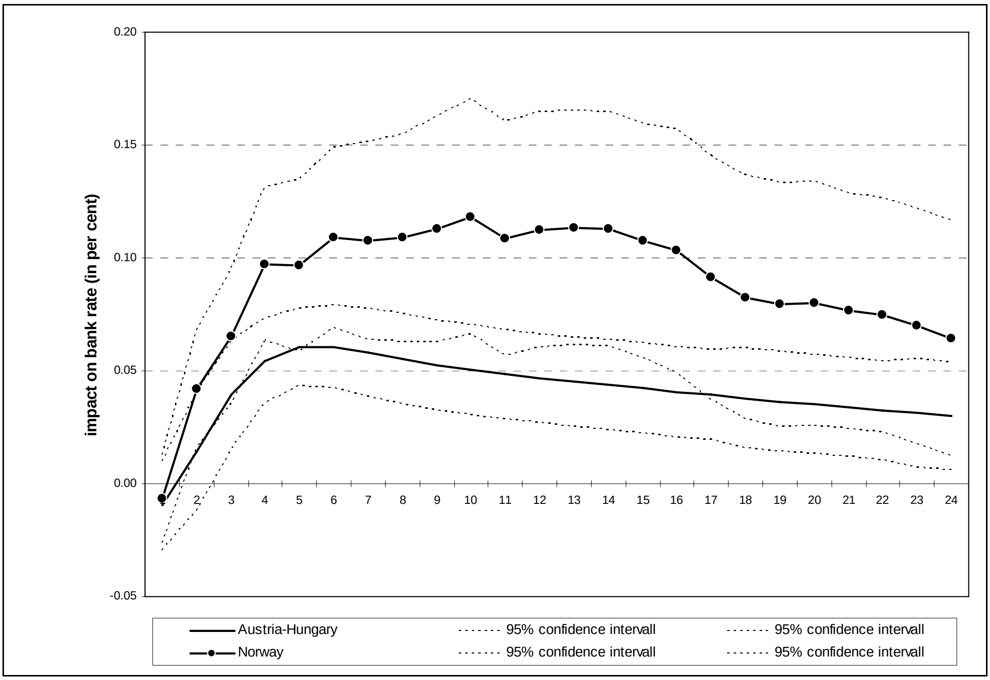
Chart 4: Response of English, German and Austro-Hungarian Bank Rates to a (Negative) 1% Gold Shock (Relative to Their Respective Gold Reserves, Based on Cholesky-Decomposition)



Source: Author’s calculations based on data as discussed in the main text.

Is chart 3 more relevant for our question than chart 4 or vice versa? In our view, controlling for the size of the average shock (as done in chart 4) misses the point: If Serbia–a country with one of the largest gold shocks in our sample (cf. table 4)–is exposed to heavy shocks, it is little comfort to know that the country would have done better if shocks had only been on a level comparable to other countries. While the VAR technique does not allow to determine the–monetary and real-economic – factors driving the size of the average shock, VARs and impulse response functions do allow to establish their size and their importance. As a consequence, we think that chart 3 is actually more relevant to our question than chart 4.

Chart 5: Response of Austro-Hungarian and Norwegian Bank Rates to a (Negative) One-standard Deviation Gold Shock (Cholesky-Decomposition).

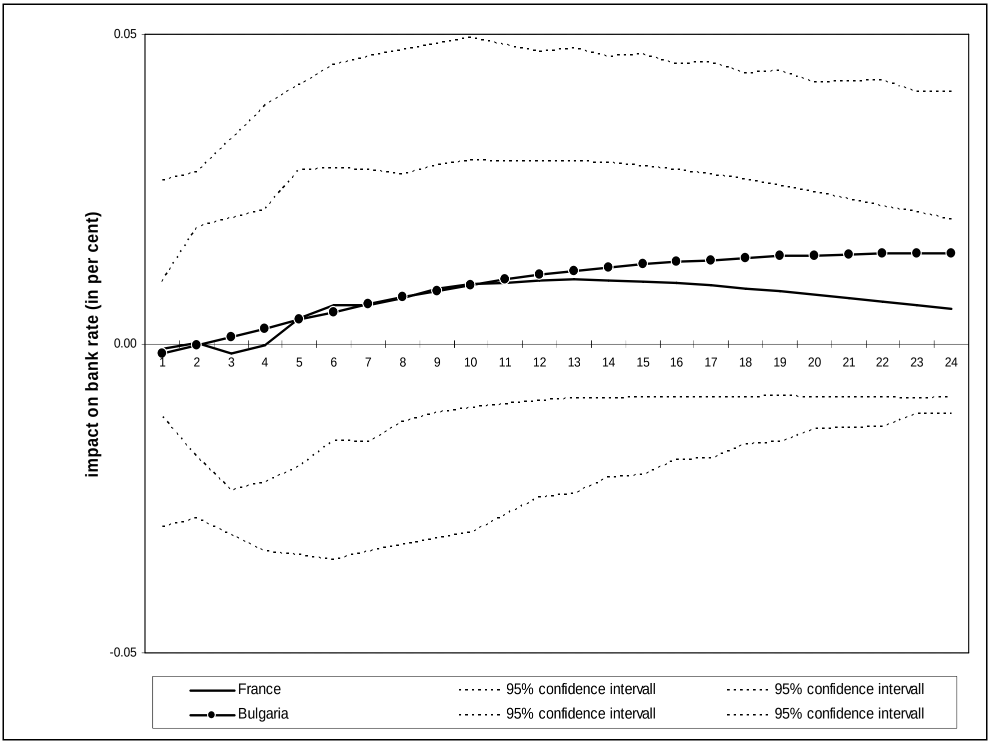


Source: Auhtor's calculations based on data as discussed in the main text.

Chart 5 compares Austria-Hungary with Norway. It shows that the Austro-Hungarian response was consistently lower than the Norwegian one. This suggests that the gold link was, at all stages of the adjustment process, harder to bear for Norway than for Austria-Hungary.

While such a finding is certainly encouraging, two problems with this approach shall not be neglected. First, how do we judge the performance of two countries if country A has a higher response initially but than falls below B's response (which is, for instance, the case for England and Germany in chart 3)? A metric would be needed to extract a single figure out of the impulse response function that would allow us to rank countries. Second, we have found it very difficult to implement this approach with countries that had infrequent discount rate changes. Chart 6 shows the cases of France and Bulgaria, both of which had, on average, less than one discount rate change per year (table 4).

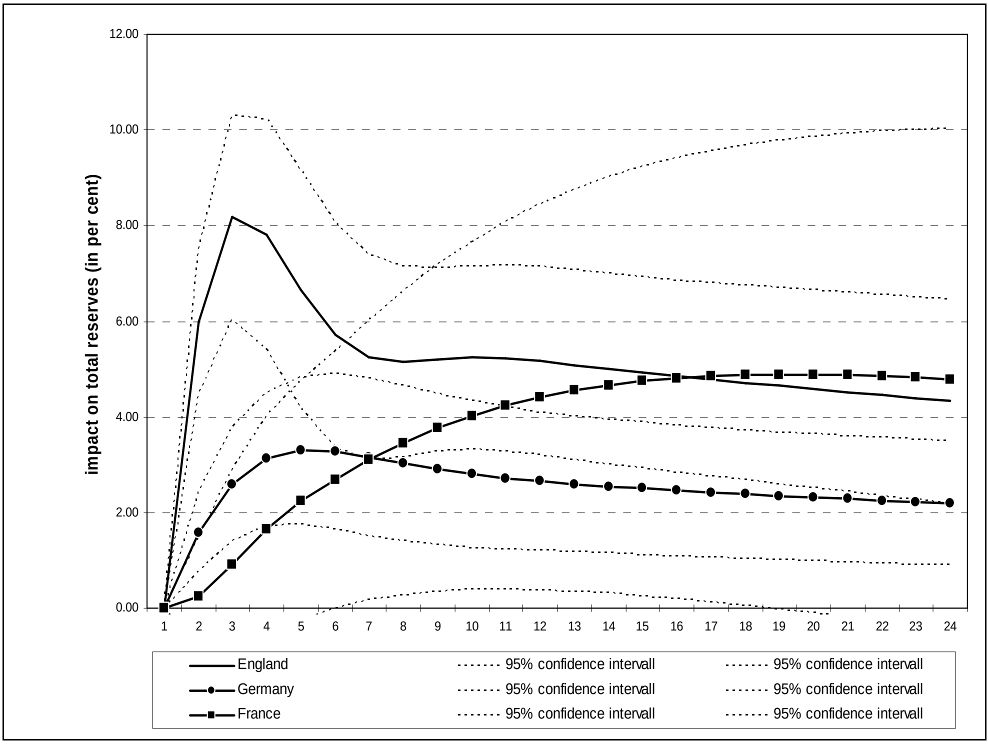
Chart 6: Response of French and Bulgarian Bank Rates to a (Negative) One-Standard Deviation Gold Shock (Cholesky-Decomposition)



Source: Author's calculations based on data as discussed in the main text.

Let us now turn to the second question: How much "pulling power" did each central bank have? This question asks for another impulse response function: How did the gold reserves react in periods 1, 2, 3 … n to a 1% increase of the bank rate? Charts 7 and 8 show the cases of England, France, Germany, Austria-Hungary and Italy. Chart 7, for instance, shows that the Bank of England could attract 8% of additional reserves (compared to its current holdings), while the Reichsbank could only attract 3.5% of additional reserves. Taking charts 7 and 8 together, we see that England had, by far, the largest "pulling power", almost twice as much as the second-best, the Bank of France. We believe that this finding needs to be taken into account when assessing what we said about the Bank of England earlier in this section. While England had, on average, larger gold shocks than any other country, it also had a substantially higher pulling power to reverse any gold drain.

Chart 7: Increase of Gold Reserves due to a 1% Increase of the Discount Rate, Comparison between England, France, and Germany

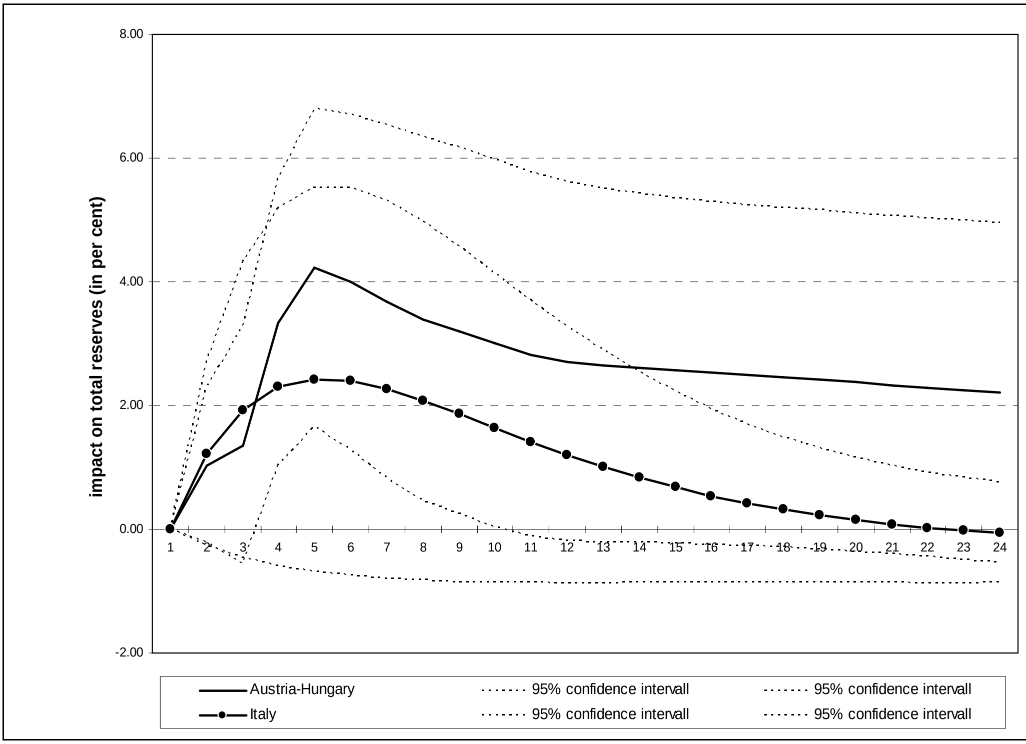


Source: Author's calculations based on data as discussed in the main text.

Again, it is interesting to see how well Austria-Hungary performs. A one-percent increase of the bank rate of the Austro-Hungarian bank would add an additional 4.2% of reserves; which is slightly more than we find for the Reichsbank. This contrasts quite significantly with Italy, another peripheral country, which had only half the pulling power.

Again, as in the case of the impulse response functions calculated above, results are not yet satisfactory for some of the other countries in our sample. The impulse response functions show virtually now – or even negative (!) – pulling power for the central banks. It does not seem to be coincidence that this problem is again more pronounced for those countries that had infrequent discount rate changes.

Chart 8: Increase of Gold Reserves Due to a 1% Increase of the Discount Rate, Comparison between Austria-Hungary and Italy I



Source: Author's calculations based on data as discussed in the main text.

6. Conclusions

This paper was concerned with one particular aspect of the literature on the Classical Gold Standard, the pre-First World War system of fixed exchange rates. Conventional wisdom has that the adjustment process to balance of payments disequilibria was very different in the case of the "core countries" (UK, US, France, and Germany) as opposed to the 'periphery'. Several studies have shown that the rich core countries could get away with frequent and sizeable violations of the "rules of the game". By contrast, it is alleged that peripheral countries had to play by the "rules of the game", thereby exposing themselves to negative repercussions on domestic economic activity.

Drawing on the experience of three core economies (England, France, Germany) and seven peripheral economies (Austria-Hungary, Bulgaria, Greece, Italy, Norway Serbia, Sweden), this paper has argued for a more nuanced perspective on the European periphery. While the conventional view might be true for some countries – most notably the Balkan economies – the experience of other peripheral countries, in particular Austria-Hungary, resembled more those of the core economies.

Three key points, all derived from a VAR model of monthly time series of gold reserves, monetary base, and interest rates for 10 European countries, stand out. First, the average gold drain ("gold shock" in VAR terminology) differed substantially across peripheral economies. We found, for instance, that shocks hitting the Serbian economy were, on average, almost ten times larger than the shocks hitting the Austro-Hungarian economy (compared to average reserve levels). As shocks differed substantially, it is little surprise that adjustment was easier for some than for others. As far as the average gold drain was concerned, we were able to show that Austria-Hungary and Italy were playing in a league with Germany and France rather than with the other peripheral economies. At the other end of the spectrum, Serbia, Sweden, Norway and Bulgaria were exposed to heavy shocks more in line with conventional wisdom regarding peripheral economies.

In a second step, we estimated the impulse response of the bank rate to an average gold outflow. This would serve as an indication of how difficult it was to maintain the gold link. Again, we saw considerable differences between peripheral economies. We were able to show that Austria-Hungary not only had the lowest bank rate response of all peripheral economies, but even remained slightly below the German response.

In a third step, we estimated the "pulling power" of the different central banks: how many additional reserves could a specific central bank attract by raising the discount rate by one percent? Not surprisingly, we found that the Bank of England had the highest pulling power, almost twice as much as the second-best, the Bank of France, which, in turn, was followed closely by the Reichsbank. Again, Austria-Hungary followed with little distance. Italy, the next placed peripheral economy, only enjoyed half as strong a reaction as Austria-Hungary.

Last but not least, it is worth pointing out that a key question remains regarding those central banks that used the discount rate tool very infrequently. Bulgaria, Greece, Serbia, but also the Bank of France, had, on average, less than one discount rate change per year. Further research is needed to establish how exactly the gold standard operated in these countries.

Published Sources

Compass. Finanzielles Jahrbuch für Österreich-Ungarn. Vienna 1896–1913.

de Mattia, R. I bilanci degli istituti di emissione italiani dal 1845 al 1936, altre serie storiche di interesse monetario e fonti. Vol. 2, Banca d'Italia: Studi e ricerche sulla moneta. Rome, 1967.

Österreichisch–ungarische Bank. Jahressitzung der Generalversammlung der Österreichisch-ungarischen Bank. Vienna 1896–1913.

Sammandrag af Bankernas Uppgifter. Stockholm 1878–1913.

Sveriges Riksbank. Sveriges Riksbank 1668–1924–1931. Statistiska tabeller. Stockholm, 1931.

Literature

Begg, D., S. Fischer, and R. Dornbusch. *Economics*. 6th edition. London: McGraw-Hill, 2000.

Blanchard, O., and D. Quah. The Dynamic Effects of Aggregate Demand and Aggregate Supply Disturbances. *American Economic Review* (1989): 655–73.

Bordo, M.D. The Gold Standard: The Traditional Approach. In: *A Retrospective on the Classical Gold Standard, 1821–1931*, edited by M.D. Bordo and A.J. Schwartz. 23–113. Chicago: University of Chicago Press, 1984.

Bordo, M.D., and H. Rockoff. The Gold Standard as a "Good Housekeeping Seal of Approval". *Journal of Economic History* 56 (1996). 389–428.

Bordo, M.D., and A.J. Schwartz, eds. *A Retrospective on the Classical Gold Standard. 1821–1931*. Chicago: University of Chicago Press, 1984.

Capie, F.H., and A. Webber. *A Monetary History of the United Kingdom. 1870–1982. Volume 1. Data, Sources, and Methods*. London, New York: Routledge, 1995.

Dam, K.W. *The Rules of the Game: Reform and Evolution in the International Monetary System*. Chicago: Chicago University Press, 1982.

Davutyan, N., and W. Parke. The Operations of the Bank of England, 1890–1908: A Dynamic Probit Approach. *Journal of Money, Credit and Banking* 27 (1995): 1099–1112.

de Grauwe, P. *Economics of Monetary Union*. 4th edition. Oxford: Oxford University Press, 2000.

Dick, T.J.O., J.E. Floyd, and D. Pope. Balance of Payments Adjustment under the Gold Standard Policies. Canada and Australia compared. In: *Modern Perspectives on the Gold Standard*, edited by T. Bayoumi, B. Eichengreen and M.P. Taylor, 218–260. Cambridge: Cambridge University Press, 1996.

Dickey, D.A., and W.A. Fuller. The Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root. *Econometrica* 49 (1981): 1057–1072.

Dutton, J. The Bank of England and the Rules of the Game under the International Gold Standard: New Evidence. In: *A Retrospective on the Classical Gold Standard, 1821–1931*, edited by M.D. Bordo and A.J. Schwartz, 173–202. Chicago: Chicago University Press, 1984.

Eichengreen, B. Central Cooperation and Exchange Rate Commitments: the Classical and Interwar Gold Standards Compared. *Financial History Review* 2 (1995): 99–117.

Eichengreen, B. *Globalizing Capital: A History of the International Monetary System*. Princeton: Princeton University Press, 1996.

Eichengreen, B., and M. Flandreau, eds. *The Gold Standard in Theory and History*. 2nd edition. London, New York: Routledge, 1997.

Enders, W. *Applied Econometric Time Series*. 2nd edition. New York, 2004.

Flandreau, M., and J. Komlos. Core or Periphery? The Credibility of the Austro-Hungarian Currency, 1867–1913. In: *Auf Heller und Cent. Beiträge zur Finanz- und Währungsgeschichte*, edited by K. Bachinger and D. Stiefel, 163–183. Frankfurt, Vienna: Überreuter, 2001.

Franke, J., W. Härdle, and C. Hafner. *Einführung in die Statistik der Finanzmärkte*. Berlin: Springer, 2001.

Fratianni, M., and F. Spinelli. Italy in the Gold Standard Period, 1861–1914. In: *A Retrospective on the Classical Gold Standard, 1821–1931*, edited by M.D. Bordo and A.J. Schwartz, 405–441. Chicago: University of Chicago Press, 1984.

Fratianni, M., and F. Spinelli . *A Monetary History of Italy*. Cambridge: Cambridge University Press, 1997.

Friedhofen, J. Die Diskontsatzpolitik der deutschen Reichsbank. PhD thesis Freie Universität Berlin, 1963.

Giovannini, A. "Rules of the Game" During the International Gold Standard: England and Germany. *Journal of International Money and Finance* 5 (1986): 467–483.

Hallwood, C.P., R. MacDonald, and I.W. Marsh. Credibility and Fundamentals: Were the Classical and Interwar Gold Standards Well-Behaved Target Zones? In *Modern Perspectives on the Gold Standard*, edited by T. Bayoumi, B. Eichengreen and M.P. Taylor, 129–161. Cambridge: Cambridge University Press, 1996.

Hawtrey, R.G. *A Century of Bank Rate*. 2nd edition. London: Longmans Green & Co., 1962.

Henriksen, I., and N. Kaergard. The Scandinavian Currency Union 1875–1914. In *International Monetary Systems in Historical Perspective*, edited by J. Reis, 91–112. London, New York, 1995.

Jeanne, O. Monetary Policy in England 1893–1914: A Structural VAR Analysis. *Explorations in Economic History* 32 (1995): 302–326.

Johnston, J., and J. DiNardo. *Econometric Methods*. 4th ed. New York, 1997.

Kissmer, F. *Die Geldpolitik in der Europäischen Währungsunion*. Hagen, 2004.

Krugman, P. Target Zones and Exchange Rate Dynamics. *Quarterly Journal of Economics* 56 (1991): 669–682.

Lütkepohl, H. *Introduction to Multiple Time Series Analysis*. Berlin: Springer, 1991.

Martín Aceña, P., and J. Reis, eds. *Monetary Standards in the Periphery: Paper, Silver, and Gold. 1854–1933*. London, New York: MacMillan Press, St. Martin's Press, 2000.

Mills, T.C. *The Econometric Modelling of Financial Time Series*. Cambridge: Cambridge University Press, 1993.

Mundell, R. The Theory of Optimum Currency Areas. *American Economic Review* 51 (1961): 657–664.

Nelson, C.R., and C.I. Plosser. Trend and Random Walks in Macroeconomic Time Series. *Journal of Monetary Economics* 10 (1982): 139–162.

Nurkse, R. *International Currency Experience. Lessons of the Interwar Period*. Edited by League of Nations. Princeton, 1944.

Ögren, A. Free or Central Banking? Liquidity and Financial Deepening in Sweden, 1834–1913. *Explorations in Economic History* 43 (2006): 64–93.

Pesaran, H., and B. Pesaran. *Working with Microfit 4.0*. Oxford: Oxford University Press, 1997.

Pippenger, J. Bank of England Operations, 1893–1913. In: *A Retrospective on the Classical Gold Standard, 1821–1931*, edited by M.D. Bordo and A.J. Schwartz, 203–232. Chicago: Chicago University Press, 1984.

Reis, J., ed. *International Monetary Systems in Historical Perspective*. London, New York: MacMillan Press, St. Martin's Press, 1995.

Schlittgen, R. *Angewandte Zeitreihenanalyse*. München: Oldenbourg, 2001.

Schlittgen, R., and B.H.J. Streitberg. *Zeitreihenanalyse*. München: Oldenbourg, 1999.

Singer, H. *Zeitreihenanalyse und Anwendungen in der empirischen Kapitalmarktforschung*. Hagen, 2004.

Svensson, L.E.O. Why Exchange Rate Bands? Monetary Independence In Spite of Fixed Exchange Rates. *Journal of Monetary Economics* 33, no. 1 (1994): 157–199.

Tattara, G. Was Italy Ever on Gold? In: *Monetary Standards in the Periphery: Paper, Silver, and Gold, 1854–1933*, edited by P. Martín Acena and J. Reis, 18–68. London, New York: MacMillan Press, St. Martin's Press, 2000.

Thomas, R.L. *Modern Econometrics*. Harlow (England), 1997.

Wysocki, J. Die österreichisch-ungarische Krone im Goldwährungsmechanismus. In *Geld und Währung vom 16. Jahrhundert bis zur Gegenwart*, edited by E. Schremmer, 143–56. Stuttgart: Franz Steiner Verlag, 1993.