An uncovered interest parity condition that worked – The continental investment demand for London bills of exchange during the gold standard (1880 -1914).

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Abstract

This paper examines an uncovered interest parity (UIP) condition that arguably held as regards the continental investment demand for London bills of exchange during the classical gold standard. At that time, practical guide books about the foreign exchanges explained in detail how exchange and interest rates were connected. For data covering the 1880 to 1914 period, modern econometric methods uncover indeed that the interest from discounting bills of exchange in the open money markets of Paris, Amsterdam, and to a large degree also Berlin, and the return from investing in London bills followed the postulated proportional relationship. This result is remarkable given the widespread rejection of the UIP with modern data.

JEL classification: F31, N13, N23

Keywords: Exchange rates; Gold standard; Uncovered interest parity condition; Uncovered interest parity puzzle

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1 Introduction

> "The Foreign Exchanges [...] are the barometer of the Money Market. Between the price of London bills, as expressed in the current rate of discount, and the price of foreign bills, as expressed in the current exchange rate, there exists at times a close sympathy [...]." Clare (1902, p.87)

Against the background of the interest parity condition, the connections between the foreign exchange and the money markets are today an established concept of international finance. It is, however, remarkable that the introductory quote has been taken from a book first published back in 1891 to provide "A Money-Market Primer and Key to the Exchanges". Written by George Clare, this book was dedicated to the practitioner in the banking industry and proofed to be sufficiently popular to be reprinted half a dozen times during the following decades.[1] Though George Clare never reached academic fame, "A Money-Market Primer and Key to the Exchanges" was a recommended book by the Council of the Institute of Bankers, which used to be the main association representing the bankers' profession in Britain (Green, 1979). Furthermore, none other than Alfred Marshall praised Clare's work as "the only tolerably good small book dealing with Banking and The Exchanges" (Groenewegen, 1985).[2]

Around 1900, research about the foreign exchanges was still in its infancy. According to Einzig (1962, p.212), the first hints to the interest parity condition appear in Thornton (1802), whilst Goschen (1861) contains a more extensive, but still informal, discussion. The theory that, under certain circumstances, exchange rates adjust unequal interest rates on different currencies only established itself in the academic literature after the First World War (Einzig, 1962; Isard, 1995, ch.5). Path-breaking contributions to the covered and uncovered interest parity condition are usually attributed to, respectively, Keynes (1923) and Fisher (1930)[3]. However, the introductory quote reveals that, among bankers, an early understanding of the forces connecting the exchange and interest rate must already have existed during the second half of the 19^{th} century. In particular, Einzig (1962, pp.184-185) states that at the time, "the establishment of closer relations between banks [...] led

[1] This paper quotes the 1902 edition. The contents of "A Money-Market Primer and Key to the Exchanges" changed barely between the first and the last edition in 1936.

[2] George Clare has also written a second practical guide entitled "The ABC of the Foreign Exchanges", which is entirely devoted to the foreign exchange market and presents several aspects of "A Money-Market Primer and Key to the Exchanges" in greater detail. Again, there are several editions and reprints of "The ABC of the Foreign Exchanges". This paper quotes the 1895 edition.

[3] Irving Fisher illustrated the UIP-condition by comparing the interest on Indian and British bonds with the exchange rate between the rupee, which was on a silver standard, and sterling, which was on the gold standard. This example with data from the 19^{th} century appeared already in Fisher (1896, ch.9).

to a considerable increase in the volume of exchange arbitrage [...] and also the volume of interest arbitrage" and that the corresponding techniques were "described in detail in innumerable practical books and articles". Specifically, it was mainly in the wealthier parts of the European continent where banks faced the decision between reinvesting deposits in the local money market, or earn interest in London by purchasing sterling-bills, which used to be a highly liquid asset issued in the world's pre-eminent financial centre (Cassis, 2010, ch.3.3). It seems to have been well-known that "bankers of the Continent begin buying up London paper as soon as the interest obtainable from it exceeds the rate to be earned on native acceptances" (Clare, 1895, p.93). Other contemporary guide book discussions about the capital flows linked to this so-called continental investment demand for London bills can be found in Clare (1902, ch.9), Spalding (1915, ch.7), and Thomas (1921, ch.8).

It is perhaps surprising that, hitherto, the enormous body of empirical research on the interest parity condition has by and large ignored the possible connection between interest and exchange rates at the end of the 19^{th} and the beginning of the 20^{th} century. Lothian and Wu (2011) employ time series data covering the past 200 years. However, due to the annual frequency of their data, they only check whether the interest parity holds over the very long haul. As far as I am aware, the only study dedicated to the decades around 1900 is Coleman (2012), who finds scant support for the uncovered interest parity (UIP) condition for the dollar-sterling exchange rate between 1888 and 1905. This result is attributed, among other things, to the large transaction costs of taking speculative positions in the New York sterling-bill market. Conversely, as mentioned above, during the classical gold standard, the London market for bills of exchange was larger, more liquid, and much closer integrated with the financial centres across the Channel. Concurring with this, the contemporary guide books emphasise that, rather than on New York, a nexus existed between the local discount rate and the investment demand for London bills of exchange on the foreign exchange markets of Paris, Berlin, or Amsterdam (Clare, 1902, pp.129ff.). To further uncover the UIP-condition during the classical gold standard (1880 - 1914), this paper endeavours to contribute to the literature by testing, by means of modern econometric methods, how closely the interest (or discount) and exchange rates were, in those days, connected between the major European financial markets.

The most remarkable result from this exercise is that the premises of the UIP-condition as regards the continental investment demand for London bills are strongly supported by the (weekly) data. Specifically, when regressing the return of a short-term investment in London bills onto the interest (discount rate) in the continental money markets, the expected intercept close to 0 and slope coefficient close to 1 tend to arise. This is surprising given the overwhelming rejection of the corresponding hypothesis with modern data, which has lead to the famous UIP-puzzle. This paper suggests that, for the advanced countries of Western Europe, there was no such puzzle during the classical gold standard.

The paper is organised as follows. The next section discusses the details of how the interest parity condition worked around 1900. Thereto, it is important to understand the behaviour of the exchange rate during the gold standard, how short and long-bills of exchange determined the relevant exchange as well as the interest (or discount) rates, and appreciate the status of the pound sterling as international currency and London as global financial centre. Section 3 presents the interest and exchange rate data, which were sourced from the weekly issues of The Economist. Section 4 introduces the econometric strategy and presents the results. Section 5 summarises and concludes.

2 Historical background

2.1 Interest parity condition now and then

Today, short-term exchange rate fluctuations are usually linked to some version of interest parity, which connects the interest rate at home, i_t, and abroad, i_t^*, with the current and the expected future value of the nominal exchange rate, denoted by s_t and s_{t+1}^e, respectively. Specifically, it is the tendency that the local interest of $1 + i_t$ and the expected return of $(1 + i_t^*)(s_{t+1}^e/s_t)$ abroad should be more or less equal which gives rise to the interest parity condition, that is

$$(1 + i_t) = (1 + i_t^*)\frac{s_{t+1}^e}{s_t}. \quad (1)$$

The exchange rate s_{t+1}^e can either be left uncovered, and the actual return depends on the realised exchange rate s_{t+1}, or be covered by the forward rate $f_{t+1|t}$.[4]

Interdependencies between exchange and interest rates are not a new phenomenon of today's

[4] In many cases, (1) is log-linearised. Then, the interest parity condition is approximately given by

$$s_{t+1}^e - s_t \approx i_t - i_t^*.$$

financial markets. As early as the 19^{th} century, bankers (Clare, 1895, 1902), and to some extent theorists (Goschen, 1861), were aware of the economic forces tying the short-term return of different currencies together. Perhaps, the reason why this has by and large been forgotten is that the currency system, the instruments used in international finance, and the structure of the international financial system differed sufficiently to hide the at the time obvious relationships to the modern eye. To prepare the ground, the following subsections endeavour to review all aspects that are relevant to uncover the interest parity condition during the classical gold standard.

2.2 How exchange rates fluctuated during the gold standard

From around 1880 until the outbreak of the First World War in 1914, the gold standard served as role model for the international currency system.[5] Though the definition of the value of a currency in terms of gold—the so-called mint-par—gave rise to officially fixed parities,[6] the rates on the foreign exchange market fluctuated nevertheless noticeably. The reason was that international gold shipments, which enforced the mint-par[7], were costly. Hence, the exchange rate could move freely within a band whose width was roughly delimited by the so-called gold-points (see e.g. Bordo and MacDonald, 2005). The left panel of Figure 3 of Section 4 illustrates this for several currencies and reveals also that, compared with what is observed today, exchange rates were much more stable. It was primarily the prospect of international gold transactions that forestalled deviations of more than 1 per cent from the mint-par. As long as gold was allowed to flow freely and central banks stood ready to convert their currency into gold, a self-correcting mechanism anchored the exchange rate at the mint-par.

Even in its heyday, the gold standard was far from being a homogenous currency system. Only a handful of countries—including Britain, France, Germany, and the Netherlands—

[5] Eichengreen (2008, ch.2) provides a brief introduction to the gold standard.

[6] For example, one pound sterling had a mint-par of around 7.322 and one French franc of around 0.2903 grammes of gold. This yields an exchange rate at mint-par of 7.322g per £/0.2903g per Fc. $\approx$ 25.22 £/Fc. The actual mint regulations were more nuanced. Different currencies were defined in gold of various fineness and by different weights. For example, whilst the British Mint Regulation stipulated that "480 ounces Troy of Gold, $11/12^{th}$ fine, shall be coined into 1869 Sovereigns", the French Mint Regulation said that "1000 grammes of Gold, $11/12^{th}$ fine, shall be coined into 155 Napoleons (of 20 Francs each)". The mint-par mentioned above results since 1 troy ounce equals 31.1035 grammes (see Clare, 1902, p.74).

[7] Consider again the example between Britain and France with a mint-par of 25.22 Fcs./£. Suppose that the market exchange rate rises to 25.30 Fcs./£. Then, it would be possible to convert one pound sterling into 25.30 French francs and change these, in turn, into $25.30 \times 0.2903 = 7.34$ grammes of gold. However, transferring this back to Britain would yield an arbitrage profit of $7.34/7.32 \approx 1.003$ or 0.3%. In the end, the increased demand for French francs from such transactions pushes the market exchange rate back towards the mint-par.

came close to the theoretical ideal of a freely convertible monometallic currency backed by gold (see Eichengreen, 2008, pp.20ff.). Across these relatively wealthy and financially advanced European nations, anchoring the official exchange rate at the mint-par meant that the remaining currency fluctuations were, arguably, almost entirely the result of international differences in interest rates, or what Clare (1902, p.94) calls the value of money. Conversely, other countries around the world restricted the convertibility of their currency into gold, retained elements of silver or bimetallic standards, or used even inconvertible paper-money. Accordingly, the exchange rates of these countries were more unstable (Einzig, 1962, 198-199) and depended also on such things as their foreign indebtedness (Clare, 1902, p.94).

2.3 Bills of exchange are a key financial instrument

Amid an era of widespread economic and political stability, the second half of the 19^{th} century witnessed an unprecedented expansion of cross-border trade and capital flows (Obstfeld and Taylor, 2004). However, owing to the costs as well as the inelastic supply of gold backed money, the necessary increase in international payments would not have happened, had most transactions been settled by means of precious metal. The required international capital flows exceeded by far the volume of trade, which was, in turn, far larger than cross-border transfers of gold (Eichengreen, 2008, pp.24ff.). This reflects that, from the Middle Ages onward, bills of exchange were commonly used to finance international payments (Denzel, 2010 ch.3, Einzig, 1962, ch.7). In essence, a bill of exchange was a written order by an issuer, called the drawer, instructing a counterparty[8], called the drawee, to pay a certain amount of money at a specific place either immediately (sight-bill) or within a given—usually three months—maturity (long-bill). Bills of exchange opened the way for cashless payment, which proofed to be much more convenient than dispatching coins or bullion.

Bills could be issued on a foreign country or city with a different currency. Since they dominated international payments during the 19^{th} century, bills of exchange determined the relevant foreign currency price for cross-border business (see e.g. Denzel, 2010, ch.3.3). As such, the market exchange rates quoted for foreign bills could deviate from the mint-par. For example, when the demand for foreign currency was relatively high and/or the supply relatively low, the market exchange rate would appreciate. What will be important for interest parity considerations is that fluctuations of the market exchange rate occurred with

[8]According to Cassis (2010, p.296), specific types of bills included cheques, which are written orders to a *bank* to pay a specified amount upon presentation.

sight as well as with long-bills.

Though bills of exchange were originally designed to finance trade (trade-bill), around 1900, they were also used for purely financial purposes (finance-bill) (Goschen, 1861, ch.3; Escher, 1913, ch.2; Clare, 1895, ch.13). It were in particular banks that recognised that bills of exchange provided an excellent instrument to earn interest from short-term investments. As an alternative to the local money market, banks of the principal countries on the European continent reinvested substantial parts of the savings deposited with them in long-bills issued in London. By way of contrast, before the First Wold War, British banks by and large ignored foreign bills (Clare, 1895, p.89; Clare, 1902, p.95).

Especially when bills of exchange were drawn on banks with a good reputation, they were seen as safe asset and, hence, deemed "first-class" quality. This provided the basis for turning a bill into a transferable financial instrument, which could be sold well before its due date to a third party, called acceptor (often a discount house), adopting the responsibility for the final payment (Cassis, 2010, p.84). From the perspective of the drawer, the selling (or discounting) of bills had the advantage of receiving early payment, but came at the price of the so-called discount-rate, that is the interest charged by the acceptor. The development of discount markets and specialised discount houses meant that bills of exchange became tradable and, hence, an "admirably liquid security" (Spalding, 1915, p.80). Owing to the pivotal role of bills of exchange within the financial system, the discount rate became one of the most closely watched interest rates during the 19^{th} century. Banks and discount houses could, in turn, approach the central bank to rediscount certain classes of bills, which gave rise to the official rediscount rate (also called the bank-rate). Under the at the time widely upheld real bills doctrine, central banks such as the Bank of England used to accept trade, but not finance bills as security. However, similar to the exchange rate, depending on the conditions in the open money market, the market discount rate could deviate from the official bank-rate.

2.4 London serves as global financial hub

Reflecting the role of Britain as leading industrial nation, during the four decades preceding the First World War, London had established itself as principal hub for arranging, funding, and insuring the bulk of international trade and payments (Cassis, 2010, pp.83ff.). Though other financial centres—in particular, Paris, Berlin, or Amsterdam in Europe and New York in America—also witnessed rapid developments, the dominance of London was such that prior to 1914, around half of global trade was financed by bills denominated in sterling, which had obtained the status of international currency par excellence (Atkin, 2005, p.5). Since bills of exchange accounted for most international payments, this implied that a group of British merchant banks and discount houses accepted and discounted vast amounts of sterling-bills (generally of three months maturity) sustaining the most liquid money market in the world. Foreign banks, through their London branches or agents, took part in this market (Thomas, 1921, pp.80ff.), and thanks to the relatively unhindered flow of capital and the technological progress in telecommunication (telegraph, telephone), financial centres became closer intertwined and a genuine international capital market began to emerge (Cassis, 2010, p.131). However, with the sterling-bill constituting an almost universally accepted security, London struggled to develop a sizable foreign exchange market. At the dawn of the 20^{th} century, it were rather the above-mentioned continental capitals, where the largest foreign exchange markets were located (Atkin, 2005, ch.1). French or German firms were indeed in constant need to discount large amounts of sterling-bills they received from exporting goods or capital, and drew similarly large amounts of sterling-bills from local banks to fund imports.

Against this background, the interest and exchange rates set in London served as international landmark. The corresponding data were published, typically on a weekly basis, in the financial press in Britain and abroad. Figure 1 provides examples taken from the 3^{rd} of March 1888 edition of The Economist. The top panel shows the London Course of Exchange bulletin, which reports the exchange rates on various foreign cities for the two most recent trading days (here 28^{th} of February and 1^{st} of March 1888) at the Royal Exchange, which was the principal market for foreign bills in Britain (see Clare, 1895, ch.8). For each foreign city, two quotations are given. The first (better) rate refers to "first-class paper", which generally meant bills of exchange involving banks with a good reputation. The second (higher) rate applied to ordinary trade bills involving less well-known firms. When contemplating the actual exchange rate data in Section 4, it will be important to remember that continental banks preferred first-class London bills (Thomas, 1921, ch.8; Clare, 1895, p.90; Clare, 1902, p.98f.). The reason was that they were highly liquid and a widely accepted, safe asset. Of note, most exchange rates in London refer to three months bills. Bearing witness to the minor importance of sight-bills in the London market, sight or cheque-rates were often only quoted on Paris or Amsterdam (Clare, 1902, pp.82, 85). Conversely, according to the middle panel, sight-rates quoted abroad *on* London existed for many financial centres including Paris, Amsterdam, and Berlin. The instantaneous transmission of financial information by telegraph implied that sight-rates in London followed those quoted abroad quite closely (Cassis, 2010, p.76; Clare, 1902, p.99). As will become clearer soon, the fact that sight-rates are reported for a small number of European countries concurs with the observation of Section 2.3 that it was commonplace for banks in France or the Netherlands to relocate idle funds when London bills promised a higher return than offered by the continental discount rates (Clare, 1910, pp.94ff; Spalding, 1915, pp.80ff.), which were also published by The Economist (see bottom panel of Figure 1). In particular, to earn a short-term return, continental banks used to combine transactions between long-bills in London and sight-bills in their local exchange markets on London. The next section turns to the details of this.

2.5 UIP and the continental investment demand for London bills

Around 1900, (i.) most international payments were settled with sterling-bills, (ii.) capital flows between the most developed countries in Europe had lead to a substantial degree of financial integration, (iii.) exchange rates could fluctuate within a band delimited by the gold points, and (iv.) the London exchange and discount markets were at the heart of the international financial system. Taken together, this gave rise to the kind of close connections between the foreign exchange and money markets that underpin the UIP-condition of (1). Owing to their key role as financial instrument determining foreign exchange and interest rates during the classical gold standard, bills of exchange provided the stepping stone for interest parity transactions. In particular, such transaction were associated with what was known as "the continental investment demand for London bills".

As mentioned above, European banks seem to have been familiar with the possibilities to exploit the different returns in London and in their local money markets. In his guide books, George Clare devotes no fewer than three chapters of "The ABC of the Foreign Exchanges" (Clare, 1895, ch.14-16) to this phenomenon and also includes an extensive discussion in "The Primer on Money Markets and Key to the Exchanges" (Clare, 1902, ch.9).[9]

To get acquainted with the interest parity condition encapsulated in the continental investment demand for London bills, it is maybe worth quoting the following example of the

[9] See also Spalding (1915, pp.80ff.) and Thomas (1921, pp.78ff.).

Figure 1: Exchange and interest rates on the 1^{st} of March 1888

London Course of Exchange

(Bulletin published in The Economist, 3rd March 1888)

On.	Usance.	Price Negotiated on 'Change.			
		Feb. 28.		Mar. 1.	
Paris	Cheques	25 25	25 30	25 27½	25 32½
Ditto	3 months	25 42½	25 47½	25 43¾	25 48¾
Amsterdam	,,	12 2¾	12 3¼	12 2¾	12 3¼
Ditto	At sight	12 0¼	12 1½	12 0¼	12 1¼
Berlin	3 months	20 49	20 53	20 48	20 52
Hamburg	,,	20 48	20 52	20 48	20 52
Frankfort	,,	20 48	20 52	20 48	20 52
Vienna and Trieste	,,	12 85	12 90	12 82½	12 85
Antwerp	,,	25 45	25 50	25 45	25 50
Petersburg	,,	19	19⅛	19	19⅛
Genoa, Naples, &c.	,,	26 07½	26 12½	26 07½	26 12½
Madrid, Barcelona, &c.	,,	46⅛	46¼	46⅛	46¼
Lisbon and Oporto	,,	52⅝	52¾	52⅝	52¾

Foreign Rates of Exchange on London

(Bulletin published in The Economist, 3rd March 1888)

	Latest Dates.	Rates of Exchange.	Usance.		Latest Dates.	Rates of Exchange.	Usance.
Paris	Mar. 1	25 30	Cheques	Rio Janeiro	Mar. 1	24 5/16 d	90 dys st
Amsterdam	— 1	12·05	Short	Buenos Ayres	Feb. 4	48⅜d	,,
Berlin	— 1	20·36½	,,	Do	Mar. 1	48¼%	
Do	— 1	20·27½	3 mos.	Montevideo	Feb. 4	51¾d	,,
Hamburg	— 1	20·27	,,	Valparaiso	— ...	...	,,
Frankfort	— 1	20·38	Short.	Melbourne	Jan.	⅜ p.sg.	60 dys st
Vienna	— 1	12·08	,,	Sydney	—	⅝ ds.bg	,,
St. Petersburg	— ...	...	3 mos.	Adelaide	—		,,
Constantinople	— 1	111·75	,,	Calcutta	Mar. 2	1/4 11/16	telegra'c
Genoa, &c.	— ...		,,	Bombay	— 2	1/4 11/16	transf'rs
Madrid	— 1	25·58	,,	Hong Kong	— 2	3/1⅛	4 m. sgt.
New York	— 1	4·85¼	60 dys st	Shanghai	— 2	4 3⅝	,,

Discount quotations current in the chief continental cities

(Bulletin published in The Economist, 3rd March 1888)

	Bank Rate. %	Open Market. %		Bank Rate %	Open Market %
Paris	2½ Feb. 16, '88]	2¼	Vienna	4 Jan., '88]	3⅛
Berlin	3 May 15, '87]	1½	Genoa	5½ Dec. '86]	5
Hamburg	3	1⅝	St Petersbrg.	5 Dec. 12, '85]	6½
Frankfort	3	1⅝	Madrid	4	4
Amsterdam	2½ May 29, '85]	2¼	Lisbon	5 Apl 86]	4½
Brussels	2½ Feb. 23, '88]	2⅜	Copenhagen	3	3

numerous passages comparing interest and exchange rates.

> "[...] If interest in this country [Britain] rises above the Continental level, bankers and money dealers in France, Germany, Belgium Holland &c. will at once begin to reduce their holding of home [...] bills [...] and will replace them by London paper, producing a demand that may amount in the aggregate to many millions, and which almost invariably carries the exchange with it. In a like manner, if interest here falls below that level the exchange will recede as rapidly as it rose, because bankers abroad will get rid of the London bills in order to buy something more remunerative" (Clare, 1902, p.96).

In practice, continental banks could earn interest either in the London bills of exchange market, or by investing in the continental money market to earn the local discount rate. To render the connection between these types of investment more intelligible, Clare (1902, pp.96-97) goes on to provide the following numerical example.

> Taking the quotations of the Paris exchange for 1888 [...] let us assume that on the 1st of March, when Bank-rate in Paris stood at $2\frac{1}{2}$ per cent., and market-rate at $2\frac{1}{4}$ per cent., and when the exchange rate was $25.46\frac{1}{4}$ long[10] and 25.30 sight, you had laid out £1000 in a three months' bill on Paris for
>
> $$\text{£}1000 \text{ à } 25.46\frac{1}{4} = \text{Fcs.}25462.50, \text{due 1st June}$$
>
> and had sold on the 31st May at sight-rate [in Paris], which happens to have been again 25.30, as before. For your £1000 you would receive back
>
> $$\text{Fcs.}25462.50 \text{ à } 25.30 = \text{£}1006 \text{ 8s. 5d.}$$
>
> which is equal [...] to a little over $2\frac{1}{2}$ per cent. per annum, and the exact return that was in prospect when the operation was initiated.[11]

[10] Note that this refers to the average between the encircled rates reported for Paris in the top panel of Figure 1, that is $25.46\frac{1}{4} = (25.43\frac{3}{4} + 25.48\frac{3}{4})/2$.

[11] The annual return can be calculated as follows. In the example, the amount of French francs (Fcs.) due on the 1^{st} of June equals 25462.50. Dividing by the sight-rate of 25.30 Fcs./£ yields a decimal equivalent in pounds sterling of

$$Fcs.25462.50/25.30 = 1006.42292.$$

This is equivalent to an annualised return of

$$100 * ((1006.42292/1000)^4 - 1) \approx 2.59\%,$$

In other words, to invest in London, three months bills were purchased *in* London at the long-rate l_t. Upon maturity, the amount of foreign currency payable was transferred into a sight-bill issued *on* London on the Continent (in Paris in the example above) at the sight-rate s^e_{t+1}. Implicitly, an expected return arose from such transactions because the long-rate was always higher than the sight-rate.[12] For an interest parity to emerge, this return had to coincide with the discount rate, denoted by i^*_t, in the continental money market. Hence, the interest parity condition as regards the continental investment demand for London bills is given by

$$(1 + i^*_t) = \frac{l_t}{s^e_{t+1}}. \tag{2}$$

It is maybe not immediately clear that (2) is an inconspicuous version of the conventional interest parity condition (1). However, the missing variables—the current exchange and the London interest rate—are embedded in the long-rate. In particular, the price of a bill payable at a future date was "based upon the sight-rate, rising and falling in agreement with it, and the amount of its deviation depends on the rate of discount ruling in the country upon which the bill is drawn [...]" (Clare, 1902, p.83). The principle that holders of long-bills had to be compensated for the opportunity costs of awaiting payment was again well-understood at the time (Goschen, 1861, pp.52ff.; Clare, 1895, ch.12; Clare, 1902, pp.82ff.; Spalding, 1915, ch.6). In particular, Clare (1895, pp.71ff.) presents detailed calculations of how the discount rate i_t in the market in which a bill was issued (here London) had to be added to the sight-rate s_t to obtain the long-rate l_t.[13] For the case of finance bills, which could not be rediscounted at the central bank, the discount rate refers to the money market and not to the bank-rate (Clare, 1895, p.72). Taken together, we have

$$l_t = s_t(1 + i_t). \tag{3}$$

Inserting (3) into (2) yields (1)! Note that the interest parity condition is uncovered, because

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where the factor 100 converts the return into percentages and the raising to the power of 4 reflects that there are four quarters (of three months) during one year.

[12] Goschen (1861, pp.121-122) provides a nice summary of the role of long-bills. "Of the aggregate indebtedness of any country, a large portion is generally embodied in bills of exchange which have some time to run. Now, these bills seldom remain in the hands of the drawers, but are partly [...] bought by bankers or capitalists who desire them as an investment of money, yielding a certain interest [...]. This interest lies in the cheaper price of the bills. [...] Accordingly, when foreign bills are bought as an investment, it is with the view of earning the higher rate of a foreign country, in the place of lower rate ruling at home [...]."

[13] The stamp duty levied on certain transactions impacted also upon the price of long-bills. Clare (1895, ch.12) shows how the London bill stamp, which amounted to less than 0.1 per cent of the bill's value, was priced into the long-rate (together with other minor expenses). A comprehensive account of the stamp duty, which depended on the type of a bill and the value of the transaction, appears in Tate (1908, pp. 32ff.).

the actual return of the continental investment demand for London bills depends on the, a priori unknown, rate of a sight-bill at future date $t + 1$ (in practice after three months or twelve weeks).[14] Hence, from the perspective of a continental bank, investing in London bills was always a bit speculative (Clare, 1902, p.98).

For several reasons, the investment demand for London bills mattered only for a handful of countries on the European continent (mainly France, Germany, and the Netherlands). Firstly, to direct large volumes of capital chasing higher returns, a sufficiently advanced and internationally integrated banking system was warranted. Perhaps, around 1900, this condition was only met in the most developed financial centres. Moreover, it is likely that only in the wealthiest countries a considerable amount of savings had accumulated to be at the disposal of the banking industry for short-term investment. Finally, it is also noteworthy that the countries associated with the investment demand for London bills were at the heart of the gold standard. Maybe, a long-established and stable mint-par made sure that the exchange rate risks were not prohibitive.

3 Weekly discount and exchange rate data

From an empirical perspective, the continental investment demand for London bills not only provided an important exchange rate determinant during the classical gold standard, but has also the advantage that the data to examine this phenomenon were already available in those days (Clare, 1895, p.94; Clare, 1902, pp.91ff.). From tables such as the ones of Figure 1 of Section 2.4, Neal and Weidenmier (2003) have compiled weekly time series of the relevant interest (discount) and exchange rates for the 1880 to 1914 period (the common sample of this paper ends in December 1913). Detailed definitions and sources of the dataset can be found in Table 3 of the appendix.

For the case of Paris, which was the most important financial centre after London (Cassis, 2010, pp.101ff.), the top left panel of Figure 3 depicts the exchange rate of long-bills in London on Paris together with the sight-rate in Paris on London. Since continental banks invested preferably in first-class paper, the long-rate refers to the lower rate in the top panel

[14] Within the present context, the covered version of the interest parity cannot be contemplated since no forward rates where published for the principal European exchanges. The establishment of the gold standard in France, Germany, the Netherlands, and Britain apparently limited the desire for hedging currency risks. Conversely, forward exchange markets existed elsewhere, especially for the Austrian Gulden, and the Russian rouble (Einzig, 1962, p.214; Flandreau and Komlos, 2006).

of Figure 1 of Section 2.4. Recall, furthermore, from the discussion of Section 2.2 that the gold standard tied the sight-rate to the mint-par of 25.22 Fcs./£. For the French franc, the gold-points determined a band of roughly [25.12 Fcs./£; 25.32 Fcs./£] within which the sight-rate fluctuated. Furthermore, the long-rate of exchange embodies an element of interest in the sense of always being above the sight-rate. Offering a better rate, a buyer of a long-bill in London could almost be certain to receive more French francs than he would have to lay out for a sight-bill in twelve weeks (three months) time. The top right panel of Figure 3 traces the realised return, defined by l_t/s_{t+12}, in terms of an annualised percentage[15] together with the annualised interest rate from discounting a bill in the open money market in Paris. Of course, especially in the event of a crisis, unexpected shifts in the exchange rate could affect an investment in London bills. However, as regards the core countries on the gold standard (including France), for decades, no crisis had been sufficiently severe to wipe-out the mint-par. Thanks to this, as postulated by the interest parity condition of Section 2.5, a close connection arises between the return of an investment in the Paris money market and the return from a bill of exchange transaction via London.

Between 1880 and 1914, The Economist provides another uninterrupted time series of the exchange rates and the discount rate of the Dutch guilder, whose mint-par stood at 12.07 Fl./£ throughout those years. Though being well beyond its golden age, Amsterdam still punched above its weight as international financial centre (see Cassis, 2010, p.125; Einzig, 1962, p.177) and Holland is mentioned in Clare (1902, p.94) as one of the countries with a considerable investment demand for London bills. Accordingly, similar to the case of the French franc, the middle panel of Table 3 depicts a co-movement between the discount rate in Amsterdam and the return encapsulated in the guilder-sterling exchange rate.

With the exception of Paris and Amsterdam, the sight-rates on other financial centres were not reported in London (Clare, 1902, p.82). However, this does not mean that these sight-rates did not exist. Rather, the non-disclosure in the London Course of Exchange bulletin might suggest that in many countries banks had little or no desire to exploit differences in the return with respect to the London financial market. In this regard, Berlin represents an

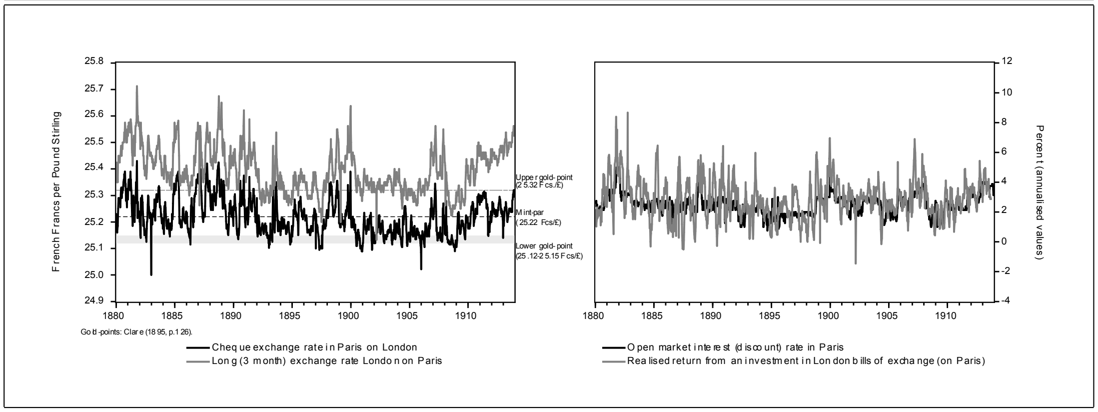
[15] To express the return from a bill of exchange transaction via London in terms of annual percentages, the following transformation is applied.

$$100 * \Big[\Big(\frac{l_t}{s_{t+12}}\Big)^4 - 1\Big]$$

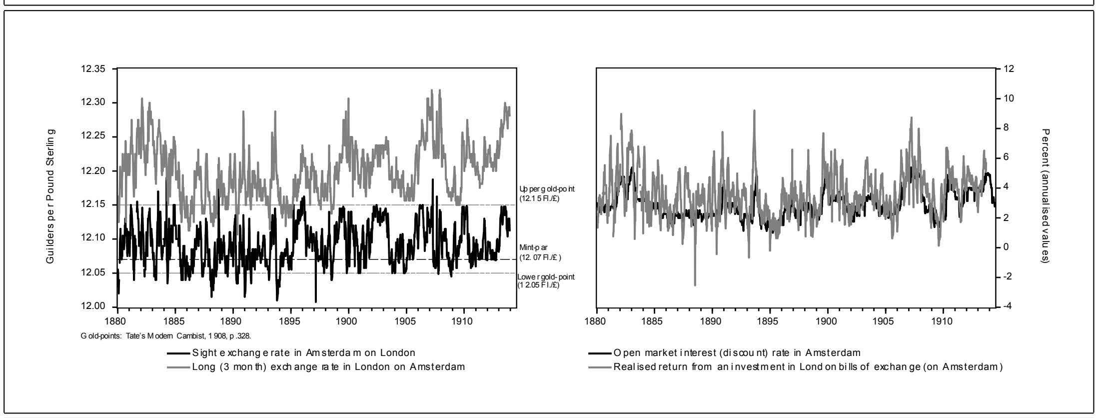
The term s_{t+12} reflects that with weekly data, the amount from a three months bill is converted back after 12 weeks. Hence, the current construction of the annual return is closely tied to the holding period of three months.

Figure 2: Interest and exchange rates (French franc, Dutch guilder, German mark)

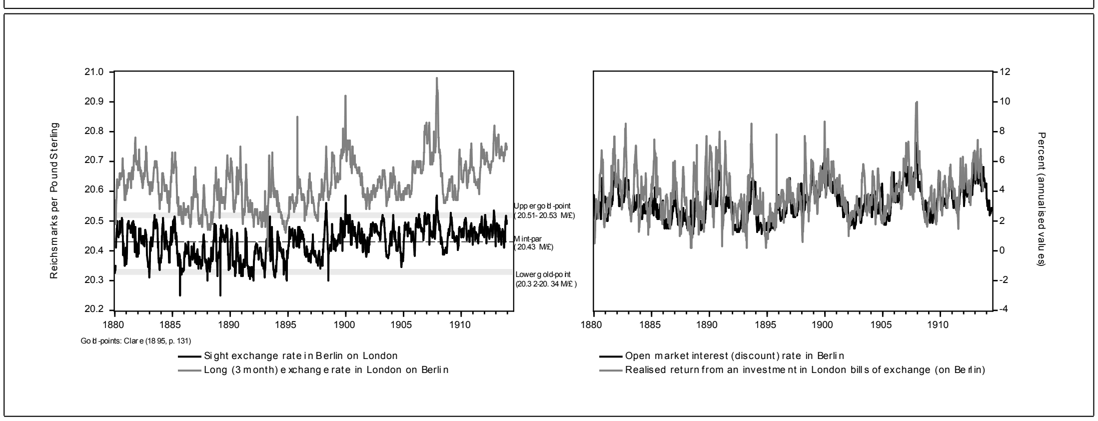
Return in Paris and London



Return in Amsterdam and London



Return in Berlin and London



intermediate case for which sight-rates did not appear in The Economist, but seem to have been reported elsewhere. For example, the tables shown in Clare (1902, p.79) list sight-rates for Berlin. In contrast to the relative decline of Amsterdam, around the 1890s, Berlin became an increasingly more important financial hub (Cassis, 2010, pp.108ff.; Flandreau and Jobst, 2005, 989). The bottom panel of Figure 3 reports the data for the German mark with the sight-rate taken from local bulletins in Berlin. Again, the familiar co-movement between the exchange rates and the discount rate arises.

For the other countries around the world and the period under consideration, no simultaneous observations for the sight and the long-rates are available reflecting, among other things, a lack of financial integration in terms of investment demand for London bills.[16] Maybe, it is surprising that this was also the case for the US-dollar, insofar as New York began to emerge as an important financial centre (Cassis, 2010, pp.114ff.). However, though the United States were an important trading partner for Britain around 1900, the capital flows were nowhere near those towards and from the principal European countries (Clare, 1902, pp.129ff.). As shown in the top panel of Figure 1, three months bills on New York where not even quoted in the London Course of Exchange bulletin (see also Flandreau and Jobst, 2005, p.984). Furthermore, due to the distance, the transaction costs to shift capital across the Atlantic were still comparatively high. Against this background, it is perhaps not surprising that Coleman (2012) found only scant support for the UIP-condition in the dollar-sterling exchange rate during the classical gold standard. In contrast to the European continent, there was probably only scarce investment demand for London bills from New York.

4 Estimating and testing the interest parity condition

A contribution of this paper is to take the UIP-condition that arguably held as regards the continental investment demand for London bills around 1900 beyond a graphical representation, and conduct thorough statistical tests by means of econometric methods that were not available at the time. To this end—assuming that expectations coincide with the future exchange rate, that is $s^e_{t+1} = s_{t+1}$—(1) is transformed into a regression equation, that is

$$\frac{s_{t+1}}{s_t} = \alpha + \beta\Big(\frac{1+i_t}{1+i^*_t}\Big) + \epsilon_t, \tag{4}$$

[16] Highly incomplete data are available for Belgium and Italy. Similar to Germany, sight-rates can be found in local publications. However, for the Belgian franc, the long-rate in London refers to Antwerp whilst, with an interruption between 1886 and 1902, only a sight-rate for Brussels can be found. Being a member of the Latin Monetary Union, via which the French mint-par of 25.22 Fcs./£ was adopted by several countries on the Continent, the exchange rate of the Belgian franc was relatively stable. Italy provided a different case. Though formally joining the Latin Monetary Union, it was one of the few European countries that only loosely pegged their currency to gold (Eichengreen, 2008, p.17). Aside from a short period in the 1880s, the mint-par of 25.22 Lire/£ was never officially instituted, wherefore the exchange rate fluctuated markedly. The Italian time-series data are also incomplete in the sense that gaps exist for the sight-rate, which refers to Italy in general, whilst the long-rate in London refers to Genoa and Naples. As regards Italy, it is perhaps not surprising that similar results than those presented in the next section show substantial deviations from the UIP-condition. For Belgium, the UIP-condition can even be rejected. However, the incompleteness of the underlying data introduce an important caveat. Hence, the cases of Belgium and Italy are not pursued further and the corresponding results are not published here, but are available on request.

where α and β are coefficients to be estimated and ϵ_t is a statistical error term.[17] With modern data, the null hypothesis that the UIP-condition holds, which would require that $\alpha = 0$ and $\beta = 1$, is widely rejected (see e.g. Hodrick, 1987; Lewis, 1995; Engel, 2014). In many studies, this famous UIP-puzzle has even manifested itself in a significantly negative estimate for β. However, transforming (2) into a corresponding regression equation yields

$$\frac{l_t}{s_{t+12}} = \alpha + \beta(1 + i_t^*) + \epsilon_t. \tag{5}$$

Again, accounting for the fact that the maturity of long-bills was usually three months or 12 weeks, this reflects merely the interest parity regression as regards the continental investment demand for London bills. Then again, coefficients of $\alpha = 0$ and $\beta = 1$ would concur with the hypothesised scenario of an identical return between discounting bills on the Continent and investing in bills of exchange in London.

Whilst in (5), the estimation of the coefficients is relatively straightforward, some vagaries arise as regards the corresponding standard deviations. In particular, a dataset combining three months' long-bills with observations that have a weekly frequency gives inevitably rise to overlaps within the sample. It is well-known that this introduces moving-average terms to the residuals, which invalidates the estimates of the standard deviations, even when they are "robust" thanks to the conventional[18] (Newey-West) method to correct for autocorrelation. A crude way to avoid this problem is to simply drop all overlapping observations. However, in the present case, this would remove more than 90 per cent of the sample. For the UIP-regression, Chinn (2006, pp.9f.) has developed a more sophisticated correction for serial correlation due to such overlap, which can be dealt with by a heteroscedasticity and autocorrelation (HAC) robust variance-covariance matrix towards a fixed-length of serial correlation of up to twice the overlap (here ± 12 weeks). Of note, regardless the chosen specification of the HAC-standard errors, they do not change the coefficient estimates.

According to Table 4 of the appendix, the conventional unit-root tests (ADF, Phillips-Perron) suggest that even at the 1 per cent level of rejection, the time series of Figures 3 are

[17]Following footnote 4, a log-linearised version of (4) is often employed, that is

$$s_{t+1} - s_t = \alpha + \beta(i_t - i_t^*) + \epsilon_t.$$

[18]Several choices have to be made before estimating standard errors that are robust to heteroscedasticity and autocorrelation. Here, the case of the "conventional HAC" uses a Bartlett-kernel, no pre-whitening of the residuals, and the SIC to determine the lag-length. Of note, changing these options did not overturn the essence of the results below.

stationary. This stands in sharp contrast to the modern behaviour of interest and exchange rates. Recall, however, from Section 2.2 that, during the 1880 to 1914 period, the mint-par had a stabilising effect on the interest and exchange rates. In any case, stationarity implies that no transformation of the data or testing for co-integration is warranted to estimate (5).

For the different continental capitals for which data are available, Table 1 summarises the baseline results. In particular, column (1) reports the OLS-estimates of (5) with conventional, robust (or Newey-West) standard errors for the Paris financial market. The estimates of 0.01 for the intercept (α), and 0.99 for the slope (β) reflect almost perfectly the interest parity condition and are indeed far from being statistically different from the priors mentioned above. This finding concurs with the numerous guide books suggesting that, around 1900, the demand for London bills of exchange aligned the discount and exchange rates between countries that had already developed a relatively sophisticated banking system, and were both on the gold standard and financially integrated through substantial capital flows. Reflecting similar conditions for the Amsterdam financial market, the corresponding coefficients in column (2) lend again empirical support to the interest parity condition in the sense of not being significantly different from the above-mentioned priors at any conventionally used level of rejection. In column (3), the results for Berlin give rise to somewhat larger—though still not significant at the 10 per cent level of rejection—deviations of the coefficient estimates from the interest parity priors. When using standard deviations accounting for the sample overlap by means of a HAC with fixed lag-lengths of ±12 observations (weeks) in columns (4) to (6), the essence of the results does not change.

Table 1: Baseline results

	(1) Paris	(2) Amsterdam	(3) Berlin	(4) Paris	(5) Amsterdam	(6) Berlin
Standard dev.	Conventional HAC			HAC with 12 leads and lags		
Intercept ($\widehat{\alpha}$)	0.01	-0.04	0.09	0.01	-0.04	0.09
	(0.08)	(0.07)	(0.06)	(0.09)	(0.08)	(0.06)
1+i_t^* ($\widehat{\beta}$)	0.99	1.05	0.92	0.99	1.05	0.92
	(0.08)	(0.07)	(0.06)	(0.08)	(0.08)	(0.06)
R^2	0.27	0.39	0.44	0.27	0.39	0.44
N	1,760	1,749	1,760	1,760	1,749	1,760
Reject ($\alpha = 0$)						
Reject ($\beta = 1$)						

Notes: This table reports estimates of (5) with dependent variable l_t/s_{t+12}. Estimation is by OLS. N denotes the number of observations. Heteroscedasticity and autocorrelation robust (Newey-West) standard errors are reported in parantheses. The null hypothesis that the UIP as regards the continental investment demand for London bills holds implies that $\alpha = 0$ and $\beta = 1$. Significant deviations from this are indicated by * at the 10% level; ** at the 5% level, and *** at the 1% level.

The definition of the coefficient standard deviations is of crucial importance when trying to reject the UIP-condition. In this regard, Flood and Rose (1995) suggest to pool the data and use a seemingly unrelated regression estimation (SURE) to account for possible contemporaneous correlations across currencies as well as currency-specific variances (cross-sectional SURE). Due to the data overlaps, the current observations from the gold standard era are also likely to exhibit correlation across time, which would warrant a period SURE.

Since the pooled unit root tests of Table 4 reject the hypothesis of an individual (see Maddala and Wu, 1999) and, for the case of the money market discount rates, of a common unit root (see Levin *et al.*, 2002), Table 2 reports results obtained from SURE without transforming the data. All specifications include cross-section specific effects. Relaxing the restriction of having no correlation across the error component of the three financial centres (Paris, Amsterdam, Berlin) barely changes the results. This is perhaps not surprising since the likelihood-ratio (LR) test, discussed in Greene (2008, p.246), cannot reject the hypothesis that the residual covariance matrix is diagonal as in the OLS-case of Table 1. Hence, for the current data, there is no statistical support for the view that a SURE would be warranted. Anyway, the main difference in the results is that the hypothesised UIP-relationship can be rejected for the Berlin financial market when calculating the coefficient standard deviations by cross-sectional SURE in columns (1) to (3). Perhaps, one reason for finding a mixed support for the UIP for Berlin is that it only emerged as foreign exchange centre around the 1890s (compare Section 4). However, moving to period SURE in columns (5) to (7) increases the standard deviations and the results are very similar to those of Table 1. Moreover, pooling the data poses the question as to whether the slope coefficients are identical. With an F-statistic of 8.59 and 0.75 of the Wald-test, this hypothesis can be rejected, respectively, for the case of cross-sectional, but not for period SURE. Then again, imposing a common slope coefficient in columns (4) and (8) does not allow to reject the null-hypothesis that the UIP-condition holds.

Further robustness checks ascertain that the UIP can, by and large, not be rejected by the data. For the sake of brevity, the corresponding Tables are not reported here, but are available on request. Firstly, the baseline results of Table 1 have been recalculated excluding observations that lie outside the gold-points, when gold shipments also affected the movement of the exchange rate. During the classical gold standard, marked deviations of the sight-rate from the mint-par were associated with events of increased political or economic

Table 2: Pooled data results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Paris	Amsterd.	Berlin	Common	Paris	Amsterd.	Berlin	Common
Standard dev.	Cross Sectional SURE			Slope β	Period SURE			Slope β
Intercept ($\widehat{\alpha}$)	0.01	-0.04	0.09	0.03	0.01	-0.04	0.09	0.03
	(0.02)	(0.02)	(0.02)	(0.02)	(0.04)	(0.04)	(0.04)	(0.06)
1+i_t^* ($\widehat{\beta}$)	0.99	1.05	0.92	0.97	0.99	1.05	0.92	0.97
	(0.04)	(0.03)	(0.02)	(0.02)	(0.06)	(0.06)	(0.09)	(0.06)
R^2		0.42		0.42		0.42		0.42
N		5,269		5,269		5,269		5,269
LR (OLS vs. SURE):		5.27				5.27		
F-stat (common vs. individual β):				8.40***				0.73
Reject ($\alpha = 0$)		*	***				**	
Reject ($\beta = 1$)			***					

Notes: This table reports estimates of (5) with dependent variable l_t/s_{t+12}. Estimation is by SURE with cross-section specific effects allowing for cross-correlation in the residuals (across cross-sections as well as across time). N denotes the number of observations. LR denotes the likelihood-ratio test on the restrictions imposed on the residual covariance matrix of the OLS estimator versus SURE (Greene, 2008, p.246). F-stat denotes the Wald-test statistic of identical coefficients for β in SURE. Standard errors are reported in parantheses. The null hypothesis that the UIP as regards the continental investment demand for London bills holds implies that $\alpha = 0$ and $\beta = 1$. Significant deviations from this are indicated by * at the 10% level; ** at the 5% level, and *** at the 1% level.

uncertainty (Clare, 1902, p.98). Instead of dropping data, Lothian and Wu (2011, p.464ff.) have proposed the smooth transition non-linear regression to account for the possibility that large deviations from UIP trigger a different adjustment. In the present context, the adjustment speed is modeled to vary according to the deviation of the sight-rate from the mint-par. However, both ways to deal with the special behaviour of the exchange rate around the gold-points leave the key results intact. The UIP-condition can never be rejected for the Paris and Amsterdam financial market, whilst there is some doubt as to whether it held for Berlin. As regards further robustness checks, the overlaps within the sample can be avoided by retaining observations at a twelve-week interval. Then, even for the case of Berlin, UIP cannot be rejected.

Possible feedback effects from the exchange rates of London bills onto the continental money market give rise to a thorny econometric issue about endogeneity. One way to address this is to instrument the continental money market discount rates with the official bank-rates set by the central bank in the respective countries. As long as these bank-rates were not driven by exchange rate considerations, the potential bias from reverse causality is absorbed. The proposition that bank-rates are exogenous is, perhaps, reasonable within the present context given that, at the time, the official aim of central banks was primarily to guarantee the convertibility of their currency into gold (Eichengreen, 2008, pp.24ff.). It is well-known that even for the currencies closely associated with the classical gold standard (sterling, French franc, German mark), monetary policy was often more broadly employed to manage the balance of payments or pursue domestic objectives by means of an active discount policy (see also Bordo and MacDonald, 2005, pp.308-309). However, under the at the time widely upheld real bills doctrine, central banks typically avoided finance bills for rediscounting. Since it were exactly these bills that were used to exploit international currency and interest fluctuations, the bank-rate might indeed be largely insulated from short-term exchange rate movements. In any case, the proposed robustness check left the main result intact. With respect to the Paris, Amsterdam, and Berlin financial markets, the UIP-condition encapsulated in the investment demand for London bills cannot be rejected.

5 Summary and conclusion

By examining the interest parity condition as regards the continental investment demand for London bills of exchange during the "belle epoque" of the gold standard (1880 - 1914), this paper is embedded in a vast literature about the financial determinants of exchange rates. The main innovation is to address this question with exchange rates between sterling and three European currencies (French franc, Dutch guilder, German mark) from the end of the 19^{th} and the beginning of the 20^{th} century. Two major observations can be taken away.

Firstly, as early as at the end of the 19^{th} century, the premise that interest and exchange rates are closely intertwined was prominently discussed in a number of guide books about the foreign exchanges and money markets. Though these books had a practical rather than a theoretical flavour, they nevertheless suggest that the idea of an interest parity condition is older than commonly thought. Above all, around 1900, it seems to have been widely-known that European banks exploit international differences in the (exchange rate adjusted) short-term return between the major gold-backed currencies. Yet, since international transactions where conducted through different financial instruments (bills of exchange), and the financial system was structured around the gold standard, the links between the exchange and interest rates in those days are, probably, no longer obvious to the modern eye.

Secondly, for the most advanced European financial centres around 1900, regressing the return implied in London bills of exchange onto the short-term interest from discounting bills in the continental money markets yields coefficients that are consistent with the UIP-condition. This result concurs with the observation that, at the time, the so-called continental investment demand for London bills aligned the exchange rates of the major gold-backed currencies with the money market interest (or discount) rates. In view of the ”puzzle” that the UIP-condition receives scant empirical support with modern data, this is a remarkable result. Why does the UIP-condition seem to hold for some currencies during gold standard? It is only possible to speculate about this question. Perhaps, the long-lasting stabilisation of the exchange rates around the mint-par reduced the currency risks to a degree, where peso problems and other issues about exchange rate risks stayed in the background.

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A Data Appendix

Table 3: Description of the data set

Variables are collected for transactions between London and 3 continental financial centres (Paris, Amsterdam, Berlin) between 1880 and 1914. The data are observed at a weekly frequency.

Variable	Unit	Description	Source
Dependent Variable:			
$\frac{l_t}{s_{t+12}}$	Per cent (annualised).	Return on a short-term investment in London bills of exchange. The return arises from investing in a long-bill, which yields l_t currency units after three-months, and converting the sum back at the sight-rate (or short-rate) s_{t+12} after three months (12 weeks). For the case of Paris, the cheque rate has been used for s_{t+12}.	Neal-Weidenmier Gold Standard Database, Neal and Weidenmier (2003). Original sources are The Economist and the Commercial and Financial Chronicle.
Explanatory Variable:			
$(1 + i_t^*)$	Per cent (annualised).	Interest on a short-term investment in the continental money market. The interest arises from discounting a bill of exchange at the money market rate.	Neal-Weidenmier Gold Standard Database, Neal and Weidenmier (2003). Original sources are The Economist and the Commercial and Financial Chronicle.

Table 4: Unit root tests

Unit Root Tests (Single variables)

	Paris		Amsterdam		Berlin	
	$(1 + i_t^*)$	$\frac{l_t}{s_{t+12}}$	$(1 + i_t^*)$	$\frac{l_t}{s_{t+12}}$	$(1 + i_t^*)$	$\frac{l_t}{s_{t+12}}$
ADF	-5.97***	-7.26***	-4.53***	-5.91***	-5.26***	-6.80***
PP	-6.37***	-9.82***	-4.46***	-9.52***	-6.08***	-8.84***

Notes: The null hypothesis is that there is a unit root. ADF is the Augmented-Dickey-Fuller test statistic. PP is the Phillips-Perron test statistic. All models contain an intercept. The lag-length has been selected via the Schwarz information criterion (SIC).

Pool Unit Root Tests

Test Statistic	$(1 + i_t^*)$	$\frac{l_t}{s_{t+12}}$
Common Unit Root		
Levin, Lin, and Chu (2002)	-2.45***	9,92
Individual Unit Root		
ADF - Maddala and Wu (1999)	72.4***	117.8***
PP - Maddala and Wu (1999)	84.9***	224.4***

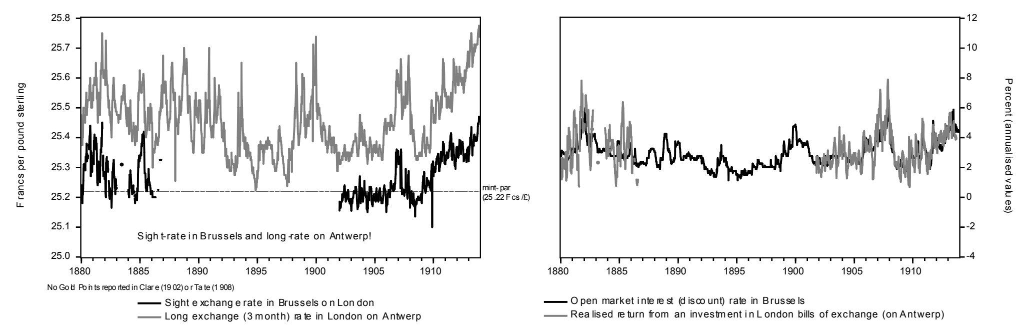
Notes: The null hypothesis is that there is a unit root. All tests statistics include an intercept. The lag-length has been automatically selected according to the SIC (starting from 20 lags). Details on the construction of the test statistics are given by the references.

B Additional results (Not for publication)

B.1 Additional results for Belgium and Italy (incomplete data)

Figure 3: Interest and exchange rates (Belgian franc, Italian lire)

Return in Brussels/Antwerp and London



Return in Genoa/Naples and London

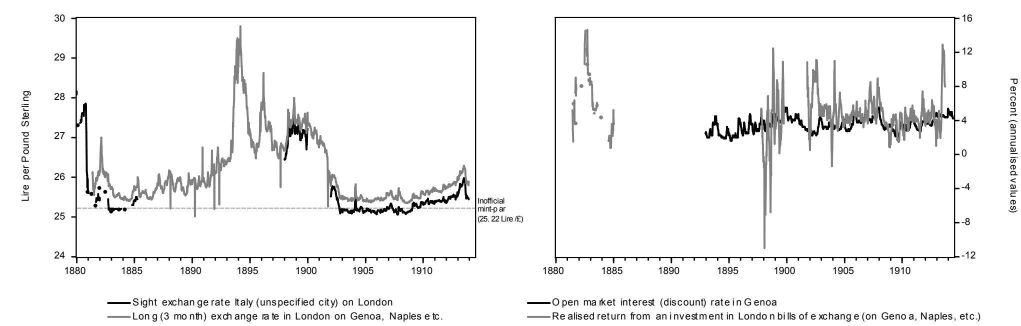


Table 5: Results

Standard dev.	(1) Brussels/Antwerp	(2) Genoa/Naples	(3) Brussels/Antwerp	(4) Genoa/Naples
	Conventional HAC		HAC with 12 leads and lags	
Intercept ($\widehat{\alpha}$)	-0.13	0.53	-0.13	0.53
	(0.07)	(0.48)	(0.08)	(0.42)
1+i_t^* ($\widehat{\beta}$)	1.13	0.50	1.13	0.50
	(0.07)	(0.46)	(0.07)	(0.40)
R^2	0.53	0.02	0.53	0.02
N	891	728	891	728
Reject ($\alpha = 0$)	*		*	
Reject ($\beta = 1$)	*		*	

Notes: This table reports estimates of (5) with dependent variable l_t/s_{t+12}. Estimation is by OLS. Heteroscedasticity and autocorrelation robust (Newey-West) standard errors are reported in parantheses. The null hypothesis that the UIP as regards the continental investment demand for London bills holds implies that $\alpha = 0$ and $\beta = 1$. Significant deviations from this are indicated by * at the 10% level; ** at the 5% level, and *** at the 1% level.

B.2 Robustness Checks

Table 6: Baseline results **(Excluding observations outside the gold-points)**

	(1) Paris	(2) Amsterdam	(3) Berlin	(4) Paris	(5) Amsterdam	(6) Berlin
Standard dev.	Conventional HAC			HAC with 12 leads and lags		
Intercept ($\widehat{\alpha}$)	0.06	-0.07	0.12	0.06	-0.07	0.12
	(0.08)	(0.08)	(0.05)	(0.08)	(0.08)	(0.05)
1+i$_t^*$ ($\widehat{\beta}$)	0.94	1.08	0.89	0.94	1.08	0.89
	(0.08)	(0.08)	(0.05)	(0.08)	(0.08)	(0.05)
R^2	0.29	0.41	0.42	0.29	0.41	0.42
N	1,612	1,625	1,729	1,612	1,625	1,729
Reject ($\alpha = 0$)			**			**
Reject ($\beta = 1$)			**			**

Notes: This table reports estimates of (5) with dependent variable l_t/s_{t+12}. Estimation is by OLS. N denotes the number of observations. According to Figure 3, the gold points are 25.12 Fcs./£ and 25.32 Fcs./£ for France, 12.05 Fl./£ and 12.15 Fl./£ for the Netherlands, as well as 20.32 M/£ and 20.53 M/£ for Germany. Heteroscedasticity and autocorrelation robust (Newey-West) standard errors are reported in parantheses. The null hypothesis that the UIP as regards the continental investment demand for London bills holds implies that $\alpha = 0$ and $\beta = 1$. Significant deviations from this are indicated by * at the 10% level; ** at the 5% level, and *** at the 1% level.

Table 7: Baseline results **(Smooth transition non-linear regression)**

	(1) Paris	(2) Amsterdam	(3) Berlin	(4) Paris	(5) Amsterdam	(6) Berlin
Standard dev.	Conventional HAC			HAC with 12 leads and lags		
Intercept ($\widehat{\alpha}$)	0.04	-0.01	0.09	0.04	-0.01	0.09
	(0.08)	(0.07)	(0.06)	(0.08)	(0.08)	(0.06)
1+i$_t^*$ ($\widehat{\beta}$)	0.97	1.01	0.92	0.97	1.01	0.92
	(0.08)	(0.07)	(0.06)	(0.08)	(0.08)	(0.06)
$(1-e^{-\lambda(s_t-\mu)^2})(1+i_t^*)$ ($\widehat{\gamma}$)	0.06	0.01	-0.001	0.06	0.01	-0.001
	(0.02)	(0.002)	(0.01)	(0.02)	(0.002)	(0.01)
R^2	0.30	0.47	0.44	0.30	0.47	0.44
N	1,760	1,749	1,760	1,760	1,749	1,760
Reject ($\alpha = 0$)						
Reject ($\beta = 1$)						

Notes: This table reports estimates of the smooth transition regression $l_t/s_{t+12} = \alpha + \beta(1+i_t^*) + \gamma(1-e^{-\lambda(s_t-\mu)^2})(1+i_t^*) + \epsilon_t$ where μ is the mint-par and λ a parameter for the adjustment speed determined by conditional least squares maximising the R^2. Estimation is by nonlinear least squares. N denotes the number of observations. Heteroscedasticity and autocorrelation robust (Newey-West) standard errors are reported in parantheses. The null hypothesis that the UIP as regards the continental investment demand for London bills holds implies that $\alpha = 0$ and $\beta = 1$. Significant deviations from this are indicated by * at the 10% level; ** at the 5% level, and *** at the 1% level.

Table 8: Baseline results **(No sample overlap)**

	(1) Paris	(2) Amsterdam	(3) Berlin	(4) Paris	(5) Amsterdam	(6) Berlin
Standard dev.	Conventional Standard Errors			Conventional HAC		
Intercept ($\widehat{\alpha}$)	-0.02	0.05	0.12	-0.02	0.05	0.12
	(0.13)	(0.10)	(0.09)	(0.13)	(0.10)	(0.08)
1+i_t^* ($\widehat{\beta}$)	1.02	0.96	0.89	1.02	0.96	0.89
	(0.13)	(0.10)	(0.09)	(0.13)	(0.10)	(0.08)
R^2	0.29	0.40	0.43	0.29	0.40	0.43
N	146	145	146	146	145	146
Reject ($\alpha = 0$)						
Reject ($\beta = 1$)						

Notes: This table reports estimates of (5) with dependent variable l_t/s_{t+12}. Estimation is by OLS. N denotes the number of observations. Observations at a 12 week interval are retained. Standard errors are reported in parantheses. The null hypothesis that the UIP as regards the continental investment demand for London bills holds implies that $\alpha = 0$ and $\beta = 1$. Significant deviations from this are indicated by * at the 10% level; ** at the 5% level, and *** at the 1% level.

Table 9: Baseline results **(Instrumenting the continental discount rate with the bank-rate)**

	(1) Paris	(2) Amsterdam	(3) Berlin	(4) Paris	(5) Amsterdam	(6) Berlin
Standard dev.	Conventional HAC			HAC with 12 leads and lags		
Intercept ($\widehat{\alpha}$)	-0.16	-0.11	0.06	-0.16	-0.11	0.06
	(0.11)	(0.08)	(0.07)	(0.12)	(0.09)	(0.07)
1+i_t^* ($\widehat{\beta}$)	1.16	1.12	0.95	1.16	1.12	0.95
	(0.11)	(0.08)	(0.07)	(0.12)	(0.09)	(0.06)
R^2	0.26	0.38	0.44	0.26	0.38	0.44
N	1,760	1,749	1,760	1,760	1,749	1,760
Reject ($\alpha = 0$)						
Reject ($\beta = 1$)						

Notes: This table reports estimates of (5) with dependent variable l_t/s_{t+12}. Estimation is by two-stage-least-squares (TSLS). Continental money market discount rates are instrumented by the official rediscount (or bank) rate set by the central bank. Heteroscedasticity and autocorrelation robust (Newey-West) standard errors are reported in parantheses. The null hypothesis that the UIP as regards the continental investment demand for London bills holds implies that $\alpha = 0$ and $\beta = 1$. Significant deviations from this are indicated by * at the 10% level; ** at the 5% level, and *** at the 1% level.