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TARGET ZONES IN HISTORY AND THEORY:  
LESSONS FROM AN AUSTRO-HUNGARIAN EXPERIMENT  
(1896-1914)<sup>#</sup>

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The first known experiment with an exchange rate band took place in Austria-Hungary between 1896 and 1914. The rationale for introducing this policy rested on precisely those intuitions that the modern literature has emphasized: the band was designed to secure both exchange rate stability and monetary policy autonomy. However, unlike more recent experiences, such as the ERM, this policy was not undermined by credibility problems. The episode provides an ideal testing ground for some important ideas in modern macroeconomics: specifically, can formal rules, when faithfully adhered to, provide policy makers with some advantages such as short term autonomy? First, we find that a credible band has a “microeconomic” influence on exchange rate stability. By reducing uncertainty, a credible fluctuation band improves the quality of expectations, a channel that has been neglected in the modern literature. Second, we show that the standard test of the basic target zone model is flawed and develop an alternative methodology. We believe that these findings shed a new light on the economics of exchange rate bands.

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## Introduction

An early experiment with an exchange-rate band was implemented in Austria-Hungary between 1896 and World War I. This experience is relevant for our understanding of the impact of exchange-rate arrangements on monetary policy insofar as this it was explicitly designed as an early version of what has become known after Krugman's seminal paper (Krugman [1991]) as a "target zone".

Economic concepts are supposedly like modern Athenas: we think of them as being born fully mature and armed. While economists generally pay insufficient attention to the archaeology of ideas, these are nonetheless significant not only in and for themselves, but because they improve our understanding of economic concepts (Blaug [2001]). Historical experience also provide rare instances for testing economic theories, in a discipline which is at pains to generate "controlled experiments".

The Austro-Hungarian experience commands our interest, because unlike so many recent attempts with exchange rate bands, which have been almost immediately put under strain before they collapsed in infamous speculative attacks, the Austro-Hungarian experiment was operating rather smoothly for almost two decades, between 1896 and 1914. Policy makers were never short of words to praise it: for instance, the Governor of the Austro-Hungarian Bank, Leon Bilinski, found this policy "original", "excellent", - indeed an "innovation" that had enhanced the bank's reputation greatly, both in the financial markets and in academia (Federn, 1911, 1388). Moreover, contemporary observers rationalized this system in strikingly modern terms: the (invisible) band provided means for the exchange rate to act as a substitute to raising the interest rate (Federn, 1910b, 662; Federn, 1911, 1391; Federn, 1912). This is surprisingly reminiscent of Svensson [1992, 1994] who emphasized that Krugman-type currency bands work by providing monetary authorities tools for maintaining stability with a measure of flexibility.

Thus, an empirical exploration of the Habsburg experience should provide us with some useful theoretical insights. Working with an entirely new data set assembled from archival sources, we first show that the creation of a credible target zone changed the very quality of expectations. It improved market performance in predicting future exchange rate changes. This intriguing "microeconomic channel" has been all but neglected in the modern literature, and yet it might be a decisive one. We also suggest that the existence of transaction costs should lead us to revise our conventional strategies for analyzing actual currency bands. The scope for a stability-autonomy trade off is better gauged by looking at the

relation between the forward premium and the exchange rate, rather than at the relation between interest differentials and exchange rates. As for testing whether a given target zone experiment is successful or not, we show that this matter requires looking at a dynamic framework.

The remainder of the paper works as follows. Section I surveys the record of the Austro-Hungarian experiment. Section II reviews a number of theoretical questions: we argue that the target zone model relies on a set of joint hypotheses, which should be gauged one at a time. Covered and uncovered interest parity (two key assumptions of modern target zone models) are thus dealt with in section III and IV. Section V provides a new test of target zones, emphasizing that the classic relation between interest rates and exchange rates should be understood as being fundamentally dynamic. We end with conclusions and policy implications.

### **Section I. Victims of dead policy makers?**

As is well known, fin-de-siècle Vienna was a hotbed of creativity in areas ranging from psychoanalysis (Freud) to philosophy (Wittgenstein) to *Art Nouveau* (Klimt) and of course to economics (Menger, Böhm-Bawerk). Much less well known, or perhaps even long forgotten, is the fact that creative genius was also at work in inventing and practicing the modern target zone theory, so that it became the backbone of the actual monetary management practices of the Austro-Hungarian bank before 1914. Svensson credits Keynes *Treatise on money* (Keynes [1931]) with this insight. It is true that Keynes had argued that there was a correspondence between the distance within the «gold points» (as exchange rate bands were known for countries adhering to gold convertibility) and the degree of short-term policy autonomy.<sup>1</sup> Wider bands, he argued, would provide more leeway for monetary policy. But he did not explain how, beyond the general notion that, within a band, exchange rates get some flexibility. As Einzig [1937] recognized in a book that was perhaps not incidentally dedicated to the famous British economist (Einzig [1937]), Keynes' insight had its roots in the pre-war policies of the central bank of the Austro-Hungarian monarchy. Einzig suggested explicitly that there was a link between Austro-Hungarian policies and Keynes' intuitions. The Austro-Hungarian policy, Einzig argued, “closely resembles Mr. Keynes's proposal for the widening of the margin between gold points” (Einzig 1937, 332-3).<sup>2</sup> Better still, as we shall proceed to show, the Austro-Hungarian target zone policy was motivated in a strikingly modern fashion that we do not find in Keynes.

Historically, these policies emerged in 1896 as a way to reconcile two conflicting goals. On the one hand, monetary authorities had been instructed to achieve, through the monetary laws of 1892 and

1893, exchange stabilization. These laws had set a fixed exchange rate target, assigning a gold equivalent to the Austro-Hungarian florin. On the other hand, authorities were concerned with retaining at least part of the protection from foreign exchange -rate shocks that was thought to have existed in the past behind the “Chinese wall” of the former system of flexible exchange rates (Lotz [1889]). In particular, Austro-Hungarian authorities wanted to avoid excessive increases in the discount rate, which would have obtained perforce, it was thought, under a fully fixed exchange rate, with adverse impact on the real side of the domestic economy (Knapp, 1909, 250; Mises 1909b). Moreover, discount rate changes were a potential source of conflict between the Austrian and the Hungarian parts of the Monarchy and their occurrence was to be minimized.<sup>3</sup>

The practical solution found to this problem was to stabilize the currency against the mark within an informal band. This policy was implemented progressively in the course of 1896 and maintained until 1914 (Figure 1). The size of the band was understood by market participants to be of about [ ? 0.4%] around parity. <sup>4</sup> From the writings of contemporary authors such as Federn [1909] one gets the sense that policy makers of the time had an intuitive understanding of the dangers of one sided bets: formal bands would have committed authorities to throw their entire reserves in an exchange rate battle at the gold point, should a confidence crises arise, so precise bounds were avoided.<sup>5</sup> The band was thus defended through discretionary foreign exchange intervention that occurred when the exchange rate approached its informal upper or lower limit, and occasional departures from the informal band could be tolerated, provided they would be short lived.<sup>6</sup>

#### Figure 1

Figure 2 illustrates the credibility record of the Habsburg experiment by plotting a measure of the expected exchange rate (specifically, we use the one month ahead forward rate) against the informal band on the florin. This is known as Svensson’s 100% credibility test. It rests on investigating whether expected rate lies within the band (credibility holds) or whether the band is systematically violated (credibility does not hold). The series for the forward rate was collected from contemporary sources (see appendix). We use the [ ? 0.4%] informal interval as fluctuation band, keeping in mind that it was understood that authorities could in some cases let the exchange rate depreciate beyond these informal points without this being a signal that the band was jeopardized. As can be seen “violations” were rare, especially after 1901, which is conventionally portrayed as the period when the stabilization of the florin was completed. In other words, future trades factored in the fact that monetary authorities would take

action to prevent continued departure from the notional currency band that was understood to operate: all in all, the florin currency band was credible.<sup>7</sup>

#### Figure 2

According to contemporary observers, credibility in turn was the lever through which monetary policy autonomy was raised. When, for instance, German interest rates increased, Habsburg monetary authorities were able to let the exchange rate go as a substitute for competitive interest rate hikes. In effect, exchange rate depreciation need not have been large, because it triggered stabilizing expectations of eventual recovery. According to Federn, for instance “the [resulting depreciation] in the exchange rate remains relatively small, because the excess demand for foreign exchange [in Vienna] disappears by itself, insofar as the small expected increase in utility to be gained through interest rate arbitrage is compensated by the risks of losses due to [the threat of a future recovery] in the exchange rate.”<sup>8</sup> Later writers accepted Federn’s analysis. Hence, Einzig wrote, “To discourage the outflow of funds, the Austro-Hungarian Bank at times allowed the [florin] to depreciate [...] Since the stability of the [florin] was above suspicion [...] few people cared to run the risk of losses through its probable recovery, simply for the sake of an arbitrage profit which, for a period of three months, was never much over 1/2 per cent.”<sup>9</sup>

Table 1 reports some evidence, which show something that contemporary observers already knew (see e.g. von Mises [1909b] p. 1010), i.e. that that exchange rate stabilization after 1896 was *not* secured at the expense of monetary policy autonomy. Discount rate changes were only marginally less frequent before 1896 (when the currency floated) than they were after (when it was pegged within a band). This explains why the Habsburg experience was remembered, by those few who remembered it, as a success.

Table 1. Frequency of official discount rate changes

Country	Number of Official Discount Rate Changes	Average Number of Changes per Annum
United Kingdom	221	6.70
Germany	136	4.12
Austria-Hungary	50	1.32
1876-1895	23	1.15
1896-1913	27	1.50

Source: Celli [1998] from *Vergleichende Notenbankstatistik*, Reichsbank, 1925.

#### ***Section II. Does credibility “buy” autonomy? Some theory and a puzzle***

*a) Theory: back to the basic target zone model*

Krugman's TZ model (Krugman [1991]) posits that exchange rates can be monitored through foreign exchange market interventions that influence fundamentals (non sterilized foreign exchange interventions that adjust money supplies when needed). Second, it presumes that agents are rational and arbitrage perfect. Perfect arbitrage implies that the forward premium (the difference between the log forward and spot exchange rates) is proportional to the interest rate differential. This is the Covered Interest Parity. Rationality implies that the forward premium is an unbiased predictor of actual exchange rate changes. This is known as the strong form of foreign exchange Market Efficiency. Along with Covered Interest Parity, foreign exchange Market Efficiency implies that the interest differential is an unbiased predictor of actual exchange rate changes: this is the Uncovered Interest Parity.<sup>10</sup>

Suppose now that a given country adopts a policy of preventing the exchange rate from departing from some interval centered on a given parity against another currency. If this policy is credible, then interest rate differentials between the two countries should be inversely related to the location of the exchange rate within the band. This is because since the exchange rate is bounded above and below (because of interventions), the likelihood of continued exchange rate appreciation, when the currency is strong, is low, and so is the likelihood of continued exchange rate depreciation when the exchange rate is weak. A measure of mean reversion is thus built into such a bounded process and rational agents realize it: they accept a lower interest rate for a currency that is momentarily weaker, because of expected capital gains on its future appreciation, and require a higher interest rate from a currency that is momentarily stronger, because of expected capital losses. Figure 3 illustrates this basic principle, by showing the predicted relation between exchange rates and interest rate differentials as they can be explicitly obtained in Krugman's model. While certainly only one among a variety of testable predictions of the model, Figure 3 has attracted much attention, and with good reasons. On top of being easily testable, it nicely captures the essence of the much vaunted exchange rate stability vs monetary policy autonomy trade off which is said to be the key advantage of an exchange rate target zone. And given that, as we found, Habsburg policy makers thought of this issue in precisely this way, uncovering the pattern exhibited in Figure 3 should guide our investigation. By many aspects, our paper should be understood as a reflection on this central theme.

Figure 3

*2) Empirical evidence: back to the future*

Early research on contemporary experiences has basically rejected this prediction of the model thus casting doubt on the possibility of a stability-autonomy trade-off (see Svensson [1992] for an early survey). Focusing on the European Exchange Rate Mechanism (1979-1998) researchers found that whenever the exchange rate depreciated towards the edge of the band, the interest rate of the weaker currency rose above that of the stronger one. *Thus, exchange rate depreciation was associated with higher, not lower, domestic interest rates, in sharp contrast to the pattern predicted in Figure 3.* Therefore, a consensus emerged that the ERM must have lacked credibility. This meant that depreciation towards the edge of the band was interpreted as a signal that a change in parity was imminent. To account for that, the Krugman model was extended to include the possibility of a devaluation in the central parity (see Bertola and Svensson [1993]). Some authors used this addition to gauge the credibility of various pegged exchange rate arrangements (Hallwood, MacDonald, and Marsch [1998]). However, since in real world situations, the likelihood of a devaluation should be correlated with the position of the exchange rate within the band, it is not clear what happens to the stability-autonomy trade off when credibility is lacking.<sup>11</sup> Clearly, without credibility, the key policy advantage of the target zone system has been lost *en route*.

But what about credible experiments, such as the one discussed in this paper? Controlling for credibility, one should be able to get a picture that is much closer to the one predicted in Figure 3. Consistently, Figure 4.a plots the relation between exchange rates and interest rate differentials for our Austro-Hungarian experiment. The result is far from satisfying: one gets a vaguely downward sloping cloud. In effect, this result is quite typical of studies focusing on exchange bands with strong credibility, such as those of the late 19<sup>th</sup> century: while earlier research has sometimes reported a negative *estimated* relation between interest differentials and exchange rates deviations from parity (Flood, Rose and Mathieson [1991], Bordo and MacDonald [1997], Bordo and MacDonald [1999]), providing some support to the existence of a trade-off, the eyeball impression one gets when the underlying data is shown is always frustrating. This is illustrated in Figure 4.b which depicts the exchange rates and interest differentials for UK vs France, 1880-1914. Again, the cloudy feeling prevails.

Figures 4.a and b

From these exercises, it is hard to conclude without doubts that earlier bands provided enough of the much desired policy autonomy, despite all the efforts that contemporaries made to secure credibility. Could the lesson be that even in the best-case scenario, the trade-off remains modest? In a sense, the



more ‘favorable’ results one obtains with credible experiences could be interpreted as devastating evidence against the existence of a stability-autonomy trade-off. Why, then, were contemporaries so impressed with the operation of the Habsburg target zone? Or is it, as we shall argue in this paper, that the story is just more subtle than has been acknowledged so far, that the standard way the basic model has been tested is flawed, and that a more careful discussion of the empirics of target zones is in order?

### ***Section III Foreign exchange market efficiency***

As argued earlier, the existence of a stability-autonomy trade-off rests on a set of joint hypotheses. Even if credibility is sustained, strong form efficiency and covered interest parities need to hold. It is thus tremendously important to determine whether or not these assumptions are warranted. Here again, the Habsburg experience should prove very useful because unlike for all other pre-1914 exchange rate regimes studied recently, Austria-Hungary had a well-developed markets for forward exchange. The data required to test both hypotheses are, thus, available.

Let’s begin with efficiency. The efficiency of 19<sup>th</sup>-century forward markets has remained virtually unexplored – perhaps because they were so few in number and the pertinent data are not readily available.<sup>12</sup> We proceed to test the efficiency of the florin/mark market before and after the stabilization of the florin. The approach we adopt follows a well established tradition (Fama [1984]). If markets are (strongly) efficient, the forward premium should be an unbiased predictor of actual exchange rate changes:

$$s_{t+1} - s_t = \alpha (f_t - s_t) + \varepsilon_{t+1} \quad (1)$$

where  $\varepsilon_t$  is a random shock,  $s_t$  is the log spot rate at month  $t$  and  $f_t$  the log forward rate quoted at month  $t$  for delivery at  $t+1$ .<sup>13</sup> Efficiency in the forward market implies  $\alpha = 1$ . (The constant  $\alpha$  measures the risk premium and is zero if investors are risk neutral). We split the period under study in a number of sub periods in order to account for a possible regime change as suggested earlier. The entire sample spans 1876:11 to 1914:7.<sup>14</sup> Within the two main “epochs” (floating exchange rates before 1896 and currency band hereafter) we consider a number of sub periods motivated by policy/institutional change as follows:

1. *The period of floating exchange rate is 1876:11 to 1896:3.*

The period of the float can be divided into three sub-periods: 1876:11 to 1889:7 before stabilization became a serious option; 1889:8 to 1892:4 during which stabilization was discussed but not decided;<sup>15</sup> and 1892:5 to 1896:3 when the basis of the stabilization was decided but not yet implemented.<sup>16</sup>

? The « target zone » period spans 1896:4 to 1914:6.<sup>17</sup>

We distinguish 1896:4 to 1901:7 from the rest of the period. Until 1901:8, the stabilization of the currency remained a unilateral Bank policy. While consistent with the laws of 1892 and 1893, this policy had been applied without official endorsement from the finance ministers. In addition the charter of the bank were due to expire in 1897 and this casts a shadow on the continuation of its policies. In 1899, after drawn-out discussions and provisory renewals, the Bank's charter was finally extended. This paved the way for the replacement of the florin in 1900 by a new unit of account (crown=0.5 florin). New gold florins were coined and put in circulation. In August 1901 the bank began paying in new gold coins (albeit it was not legally committed to doing so). This decision, after a somewhat extended transition period, opened what is customarily described as the heyday of the florin currency band that lasted about 13 years until WWI (Von Mises, [1909], p. 203).

Table 2. Foreign Exchange Market Efficiency Tests :  $\beta$   $\gamma$   $\delta$   $\epsilon$   $\zeta$   $\eta$   $\theta$   $\iota$

Period	$\beta$	$\gamma$	Adj. $R^2$	D W	F test
1) 1876:12 - 1889:7 N= 152 (a)	-0.000 (-.144)	1.47 (1.45)	.01	2.0	F(2,150)=0.13 (*)
2) 1889 :8 - 1892 :4 N= 33	-.001 (-.43)	1.42 (.68)	-.02	1.9	F(2,31)=0.096 (*)
3) 1892 :5 - 1896 :3 N=47	.001 (1.4)	-1.13 (-1.63)	.03	1.8	F(2,45)=5.04
3') 1876 :12 - 1896 :3 N=232 (a)	-0.26 $10^{-3}$ (-0.42)	0.54 (0.89)	-0.8 $10^{-3}$	1.99	F(2,230)=0.46 (*)
4) 1896 :4 to 1901 :7 N= 64	-.000 (-.52)	.10 (.32)	-.01	2.3	F(2,219)=3.52
5) 1901 :8 to 1914 :8 N= 157	.000 (.15)	.99 (5.23)	.14	2.0	F(2,155)=0.01 (*)

Source: authors' computations: see text. T-stats in parentheses (a) based on "average" series, due to data limitations. When average and Geld series coexist, they yield virtually identical results.. (\*) = null that  $\beta = 0$  and  $\gamma = 1$  accepted at 5%.

The results point to a sharp contrast in the performance of the markets during the period of the float and the period of target zone, especially after 1901 (Table 2). Strictly speaking, market efficiency is not inconsistent with the data for the period before 1901 but this comes from the low explanatory power of the equation under scrutiny: low t-statistics, occasionally negative estimated  $\beta$ s, negligible adjusted  $R^2$ , and F tests generally point towards low market efficiency or outright inefficiency before the currency was stabilized.<sup>18</sup> After the interregnum of 1896-1901, however, the golden age of the florin target zone provides support to the strongest form of the efficient market hypothesis (Table 2, Row 5).<sup>19</sup> Individual parameter estimates are found very near to the values implied by the risk neutral EMH ( $\beta = 0$  and  $\beta = .99$ ). More fundamentally, significance increases dramatically as illustrated by the rise in adjusted  $R^2$ . Finally, the F-test leads us to accept unambiguously the null of market efficiency.<sup>20</sup> The conclusion is that the stabilization of the florin after the turn of the century produced a considerable improvement in the efficiency of the foreign exchange market. Variations of the forward rate became easier to predict.<sup>21</sup>

The previous conclusion has far-reaching consequences for the relation between spot rates and the implicit rate of expected exchange rate changes one can derive from the forward premium: efficiency in a forward market when the underlying exchange rate is kept in a band (and thus mean reverting) should translate into a negative relationship between the location of the exchange rate and the expected rate of depreciation. Figure 5 illustrates this. A clear downward sloping relation between exchange rate location and the implicit expected depreciation is visible. This relation is the closest thing ever shown to support the pattern hypothesized in the Krugman model. It is doubtless one of this paper's most striking pieces of evidence and should thus receive due emphasis.

Figure 5

#### **Section IV. Covered interest parity: integration of money markets and foreign exchange markets**

At this stage, one might conclude that by the end of 1901, market efficiency had improved in such a way that the market expected a future appreciation when the currency was weak and a future depreciation when the currency was strong. This undoubtedly created a favorable environment for policy makers, who should have been able, as a result, to rely in market expectations as a stabilizing device. Specifically, they should not have felt any pressure for raising their base rate when the currency

was weak, since market participants expected eventual capital gains. Why, then, is it that we find the pattern in Figure 4.a, whereby the apparent trade-off is far from obvious? Answering that question requires carefully documenting covered interest parity.

a) Covered interest parity, a cursory look

Formally the condition that needs to be tested (recalling that interest rates are given as percentage per annum while forward rates are one month ahead contracts) reads (both  $f$  and  $s$  are in logs. We multiply by 12 to obtain annualized rates, since the forward rate is for the next month, and by 100 to obtain percentage):

$$\ln f_t - s_t = 1200 (i_t - i_t^*) \quad (2)$$

Figure 6a and b provide a crude test of equation 2, relying on market and official rate differentials. The open market should be preferred because it is the relevant rate for covered interest parity arbitrage. On the other hand, the official rate is the one that was of concern to policy makers. This is why we use both. The charts suggest that it was only after 1895 that the resemblance between expected depreciation and interest differentials improved. But even then the similarity was not perfect. Covered interest parity cannot be taken for granted, which may explain why the link between exchange rates and interest rate differentials is loose.

Figures 6.a and b

b) Covered interest parity, 2: a naïve test

To go beyond the previous exercise, a popular test of CIP (MacDonald [1988]) is to run:

$$\ln f_t - s_t = 1200 (\beta + \gamma (i_t - i_t^*)) \quad (3)$$

where the null that (2) is true is accepted if one cannot reject  $\beta = 0$  and  $\gamma = 1$ . Table 3.a reports straight OLS output. Table 3.b controls for the auto-correlation of residuals. Once again the results indicate that a transformation occurred around 1896. At the same time, these tests lead to *reject* covered interest parity for all periods. The integration of money and foreign exchange markets was not perfect.

Table 3.a. Integration of money and FX markets: OLS estimates of  $\ln f_t - s_t = 1200 (\beta + \gamma (i_t - i_t^*))$

Period	$\beta$	$\gamma$	Adj.R <sup>2</sup>	DW	F test
MARKET RATES DIFFERENTIALS					
1876 :11-1914 :8	-0,15 (-2,72)	0,52 (10,63)	0,17	1,60	102,35 (0,00)
1876 :11-1896 :3	-0,26 (-2,38)	0,55 (6,25)	0,14	1,68	54,08 (0,00)

1896 :4-1914 :8	-0,08 (-2,03)	0,58 (9,76)	0,30	1,36	51,14 (0,00)
BANK RATES DIFFERENTIALS					
1876 :11-1896 :3	0,15 (3,61)	0,50 (8,25)	0,12	1,48	5,84 (0,00)
1876 :11-1896 :3	0,04 (0,56)	0,60 (5,21)	0,10	1,55	6,47 (0,00)
1896 :4-1914 :8	0,24 (6,25)	0,50 (8,88)	0,26	1,28	78,60 (0,00)

Source: authors' computations: see text. T-stats in parentheses. Results with Vienna's minimum market rate. coefficients: t-statistics in parentheses; tests on restrictions: F-statistics, probability in parentheses

Table 3.b. Integration of money and FX markets: Estimates of Equation

$$f_t = s_t + \alpha_1 \Delta f_t + \alpha_2 \Delta s_t + \alpha_3 \Delta i_t + \alpha_4 \Delta i_t^* + \alpha_5 u_t + \alpha_6 u_t + \alpha_7 u_{t-1} + \alpha_8 u_t$$

Period	$\alpha_1$	$\alpha_2$	$\alpha_3$	Adj. R <sup>2</sup>	DW	F test
MARKET RATES DIFFERENTIALS						
1876 :11-1914 :8	-0,12 (-1,87)	0,47 (7,67)	0,20 (4,34)	0,20	2,09	79,06 (0,00)
1876 :11-1896 :3	-0,23 (-1,82)	0,51 (5,13)	0,16 (2,36)	0,16	2,06	43,00 (0,00)
1896 :4-1914 :8	-0,05 (-0,83)	0,48 (7,15)	0,35 (5,60)	0,38	2,10	42,87 (0,00)
BANK RATES DIFFERENTIALS						
1876 :11-1914 :8	0,15 (2,75)	0,48 (6,58)	0,25 (5,56)	0,18	2,12	27,16 (0,00)
1876 :11-1896 :3	0,05 (0,47)	0,57 (4,27)	0,22 (3,36)	0,14	2,10	5,58 (0,00)
1896 :4-1914 :8	0,22 (4,09)	0,45 (6,44)	0,37 (5,87)	0,36	2,11	48,90 (0,00)

Source: authors' computations: see text. T-stats in parentheses. Results with Vienna's minimum market rate. coefficients: t-statistics in parentheses; tests on restrictions: F-statistics, probability in parentheses

c) Covered interest parity: within the neutral band

This last conclusion however, should be qualified. The rationale for equation (2) rests on an arbitrage relation. But arbitrage entails costs. This motivates an alternative strategy that compares actual deviations from interest parity to arbitrage costs. Estimating arbitrage costs is difficult. It requires a knowledge of the operation of foreign exchange and money markets. This has often led modern researchers to use indirect routes (Frenkel and Levich [1975], MacDonald [1988]).

In our case, however, a direct measure can be obtained. Consider a banker who performs CIP arbitrage between Berlin and Vienna. We know from Einzig ([1937], p. 332), that this practice was "highly developed in Vienna for decades before the war". Our banker has access to both money markets where he can lend or borrow at the prevailing open market rate. If (2) does not hold, for

instance, when the Berlin rate is too high, arbitrage is feasible. This involves borrowing florins for one month in Vienna, selling the proceeds spot, then lending in Berlin for one month while covering the operation through a forward contract.<sup>22</sup>

The expenses involved in the arbitrage are straightforward: the operation implies one spot purchase and one forward sale. Thus, the banker ends up paying the bid-ask spread once (he is a seller in one transaction and a purchaser in the other one). This amounted, to a 0.1 florin charge when the exchange rate fluctuated around fl. 60 or about 0.166% of the transaction, a number which as a matter of fact is quite in line with modern spreads. This translates into an interest loss of about 2% per annum (0.166% times 12 months). Formally:

$$i_t - i_t^* - \frac{1}{12} \frac{df_t}{f_t} \approx 2\% \quad (4)$$

The simple test is the following: we accept the null that CIP holds if (4) holds. Figure 7 does just this comparing the “spread” between interest differentials and expected rate of exchange rate change to the “neutral band”. As seen, some violations occurred before 1896, but they virtually disappeared thereafter. Moreover, the deviations were found after that date in a much narrower range than the neutral band. From this respect, integration of the money and foreign exchange markets prevailed by and large throughout the entire period under study and probably improved after 1896. But the important conclusion here is that the apparently weak relationship in Figure 4.a can be understood as the natural consequence of arbitrage costs. The intuition is nothing else than the familiar principle of Tobin taxes: transaction costs on interest rate arbitrage have dramatic effects over short horizons. But this short term horizon is precisely the one over which the target zone can bring autonomy. In the end, the economics of Tobin taxes and those of target zones interfere with each other causing the relationship to be blurred in Figure 4.a. The stability-autonomy trade-off is concealed behind a veil of arbitrage costs.

### Section V. Beyond Covered Interest Parity

The previous discussion has shown that the success of a credible target zone cannot be gauged by looking at the relation between interest rate differentials and exchange rates since the former are only imperfectly related to expected exchange rate changes. On the other hand, from a policy point of view it is the ability to keep a low interest rate when foreign interest rises, and purchase that through a depreciated exchange rate, which makes a target zone system especially attractive. In other words, we need to drive our story home, and explore the dynamic causality between interest differentials and expected exchange rate changes.

a) A new test for Target Zones

Figure 7 has shown that deviations from CIP were on average small and non-persistent. This implies that there was a mechanism that drove the interest rate differential towards the expected rate of depreciation or vice versa. Theory is a guide to determine the direction of causation: the basic principle on which rests the conduct of monetary policy in a target zone, is to use exchange depreciation as a substitute for interest rate changes. In other words, when German interest rates soared, Austro-Hungarian authorities should have been able not to follow suit. Instead, they could let the spot exchange rate fall and/or the forward rate rise in order to increase the forward premium. Thus, one testable implication of the model with arbitrage costs, is that changes in the interest differentials should cause changes in expected exchange-rate changes and not the other way round.

This reasoning motivates the formal test of successful TZ management which we provide here. This test relies on a two dimensional VAR model that involves both terms of the covered interest parity equation. Formally we have:

$$\begin{aligned}
 &DEF_t = \alpha_0 + \alpha_1 DEF_{t-1} + \alpha_2 DEF_{t-2} + \beta_1 i_{t-1}^* + \beta_2 i_{t-2}^* + \epsilon_{1t} \\
 &i_t = \gamma_0 + \gamma_1 DEF_{t-1} + \gamma_2 DEF_{t-2} + \delta_1 i_{t-1}^* + \delta_2 i_{t-2}^* + \epsilon_{2t}
 \end{aligned} \tag{5}$$

where DEF is the expected rate of exchange-rate change, and  $\epsilon_i$  (i=1,2) are random shocks.

We argue that the data supports the views of contemporaries that the Habsburg TZ was successful and purchased short term policy autonomy if we find that  $i_t^*$  causes  $DEF_t$ , and that  $DEF_t$  does not cause  $i_t^*$ . Results are presented in Table 4.a and b. The lag structure, VAR(4), was selected using optimizing procedures (conclusions are unaffected to the number of lags selected). In line with the discussion in the paper, we report separate results for the period of floating exchange rates and for the currency band era.

**Table 4.a. Dynamic causality within the neutral band: market rates**

	1876-1896		1896-1914	
Dep. Var.	DEF	$i^*$	DEF	$i^*$
DEF(-1)	0,058 (0,87)	0,05 (1,75)	0,30 (4,21)	-0.13 10 <sup>-2</sup> (-0,02)
DEF(-2)	0,23 (3,62)	-0,017 (-0,54)	0,06 (0,85)	0,03 (0,46)
DEF(-3)	0,16 (1,65)	0,034 (1,03)	0,19 (2,58)	-0,06 (-0,85)

DEF $\gamma$ (-4)	0,19 (3,00)	0,031 (0,94)	-0,08 (-1,14)	-0,02 (-0,30)
i-I <sup>*</sup> (-1)	0,17 (1,33)	0,57 (8,56)	0,41 (5,30)	0,57 (7,70)
i-i <sup>*</sup> (-2)	-0,01 (0,06)	0,13 (1,77)	-0,20 (-2,26)	-0,06 (-0,78)
i-i <sup>*</sup> (-3)	0,11 (0,07)	0,17 (2,30)	0,09 (1,04)	0,23 (2,76)
i-i <sup>*</sup> (-4)	0,06 (0,50)	-0,13 (-1,9)	-0,09 (-1,12)	-0,08 (-1,09)
Constant	-0,10 (-0,90)	0,19 (3,46)	-0,02 (-0,36)	0,14 (3,17)
Nobs	229		221	
Adj-R2	0,27	0,67	0,36	0,35
Granger causal.	1,36	1,91	7,37 (*)	0,27
Schwartz BIC	-0,89		-2,61	

Source: authors' computations (see text). Periods are 1896:11 to 1896:3 and 1896:4 to 1914:8.(\*) significant at 5% T statistics in parenthesis – the coefficients of the lagged values of the other variable are bold faced. Time units are monthly observations.

Results are revealing. For the period of the float prior to 1896, for both equations, none of the coefficients of the lagged values of the other variable (bold-faced) is significant (Table 4a, columns 1 and 2, and Table 4.b, columns 1 and 2). The Granger causality values reflect this by being small and insignificant.<sup>23</sup> By contrast, after 1896, we observe the emergence of an obvious one-way causality. It goes from the interest rate differential to the expected rate of depreciation, regardless of the interest differential we focus on.<sup>24</sup> This shows that once the band was adopted, a widening in the Vienna-Berlin interest rate spread, instead of leading to an automatic correction (with say, Austro-Hungarian rates tracking German rates) generated in the next few weeks a widening of the forward premium. Moreover, the estimated dynamic structure for bank-rates differentials (column 2 and 4 Tables 4a and 4b), is virtually identical before and after 1896, (except that during the float, bank rates tended to be marginally higher in Vienna than in Berlin, whereas during the TZ period it was the other way around). In other words, despite the transition to a fixed exchange rate regime Austro-Hungarian monetary authorities had been able to change their discount rate as infrequently in response to foreign shocks as they did prior to 1896, and even, on average, to lower it a bit. The stabilization of the currency within a band had thus succeeded in providing at least as much leeway as flexible exchange rates had done in the past. Despite having stabilized their currency within a narrow band, authorities could use the exchange rate as a substitute to interest rate hikes, following the lines of a literature that was not yet written.



**Table 4.b. Dynamic causality within the neutral band: bank rates**

	1876-1896		1896-1914	
	???	(2)	???	(4)
	DEF	$i-i^*$	DEF	$i-i^*$
DEF (-1)	0,07 (1,16)	0,02 (0,78)	0,34 (4,82)	0,03 (0,60)
DEF (-2)	0,25 (3,94)	0,02 (0,83)	0,02 (0,27)	-0,05 (-0,88)
DEF (-3)	0,12 (1,96)	0,03 (1,06)	0,24 (3,34)	$0,85 \cdot 10^{-2}$ (0,14)
DEF (-4)	0,21 (3,31)	-0,006 (-0,25)	-0,07 (-0,96)	$0,40 \cdot 10^{-2}$ (0,07)
$i-i^*$ (-1)	0,17 (1,08)	0,76 (11,12)	0,38 (4,23)	0,78 (10,81)
$i-i^*$ (-2)	0,04 (0,19)	-0,02 (-0,31)	-0,21 (-1,87)	0,04 (0,52)
$i-i^*$ (-3)	-0,19 (0,93)	0,06 (0,74)	0,10 (0,93)	-0,01 (-0,16)
$i-i^*$ (-4)	0,12 (0,71)	-0,08 (-1,29)	-0,18 (-1,97)	-0,10 (-1,37)
Constant	0,05 (0,71)	0,08 (2,5)	0,08 (1,92)	-0,05 (-1,59)
Nobs	229		221	
Adj-R2	0,26	0,59	0,35	0,61
Granger causal.	0,66	1,02	5,93 (*)	0,23
Schwartz BIC	-1,32		-2,84	

Source: authors' computations (see text). Periods are 1896:11 to 1896:3 and 1896:4 to 1914:8. (\*) significant at 5% T statistics in parenthesis – the coefficients of the lagged values of the other variable are bold faced. Time units are monthly observations.

*b) A case study: the international financial crisis of 1907.*

Before we turn to the conclusions, it might be useful to spend some time on one specific episode which attracted much attention and was conventionally described as the masterpiece of Habsburg monetary authorities (Federn [1909], Einzig [1937]). The occasion was the international financial crisis of 1907, which originated in the US and reverberated quickly in major financial centers such as London and Berlin. The ability of the Habsburg monetary authorities to maintain a lower discount rate than the one prevailing in Berlin throughout the crisis, in spite of considerable pressure on the crown was widely described at the time as a high spot of monetary management.

Figure 8, derived from daily data, shows why contemporaries were enthusiastic. As can be seen before the Fall of 1907 when the crisis erupted, the florin tended to be relatively appreciated with respect to the mark (close to its lower boundary). During that period, the spot rate was systematically below the forward rate suggesting that market participants found currency depreciation more likely. As the crisis developed, the exchange rate depreciated, at the same time when the interest differential with

Germany was growing larger. This is because as the spot rate depreciated, the forward rate rallied, ending its course below the spot rate. As a result there was no capital flight, and thus no special pressure to raise the official interest rates in Vienna, because few people cared to run the risk of a capital loss through currency recovery.

Clearly, in periods of crises as well as during “normal” times (as captured by our efficiency regressions), market participants expected exchange rates to return towards parity. Increased efficiency for a credible system did imply that agents systematically expected the exchange rate to appreciate when it was low and to depreciate when it was high. And this was something on which Austro-Hungarian monetary authorities could depend.

Figure 8

### **Conclusion**

This Austro-Hungarian success story, in stark contrast to the utter failure of modern experiments with target zones, does hold a lesson for today: while letting the Austro-Hungarian currency fluctuate within an extremely narrow margin of less than 1%, Habsburg monetary authorities were, indeed, able to achieve their objective of minimizing the frequency of interest-rate changes, and especially to avoid reacting to foreign crises. In effect, they changed their discount rate 3 times less frequently than their German counterpart, in spite of the tight financial links that connected Berlin and Vienna.

At a general level, the device rested, as has been emphasized in the theoretical literature, on exchanging interest rate stability for exchange rate flexibility, and on a firm commitment to long-run exchange rate stability so as to achieve credibility. Yet, as the paper argues, there were two more important features that played a decisive role in the outcome.

The first was foreign exchange market efficiency. We observed a dramatic increase in efficiency after the currency was stabilized within its band: after the turn of the century, the forward premium became an unbiased predictor of future exchange rate changes. And this implied that the market expected the florin to appreciate when it was weak and to depreciate when it was strong. That efficiency developed along with the implementation of the currency band is an important finding. It implies that the “rules” that define a given exchange rate regime do not only influence the behavior of policy makers, but also the very quality of expectations. This result can be interpreted in relation to the inability of forward rates to predict future exchange rate changes over short horizons when a currency is floating. In the highly uncertain environment of foreign exchange markets, the credible commitment of monetary policies to

keep the exchange rate within a narrow band, comes as a very relevant piece of information that improves the quality of forecasts. In turn, policy makers get a reward for this provides them with a measure of short term policy autonomy. The finding that the Austro-Hungarian currency band was defended with just a few more discount rate changes than needed during the period of float suggests that there was something like a free lunch. Our analysis explains why: by fostering market efficiency, a currency band may help policy makers to make full use of the market mechanism, a channel which we do not think the modern literature has ever recognized.<sup>25</sup>

Second, our study of covered interest parity has demonstrated that one conventional way through which recent authors have tested, following Svensson, the target zone model (i.e. by running regressions of interest rate differentials on exchange rate deviation from parity and checking whether the estimated coefficient is negative) is inappropriate. Covered interest arbitrage involve costs, which albeit small, prove considerable over the short run horizon which is precisely the horizon for which a TZ can provide some autonomy: the logic of Tobin tax conceals the relation between exchange rate deviation from parity and interest differentials behind a cloud of arbitrage costs: but it does not destroy it – much to the contrary. Granger causality tests enables us to go beyond deceptive features and uncover a phenomenon which is at the heart of the economics of successful TZ: namely, that there should be a dynamic, one way, causation going from interest rate differentials to the forward premium. Thus when money rates rose in Berlin, Vienna could avoid to respond in kind. Instead, Austro-Hungarian authorities could let the exchange rate depreciate, trusting that before long markets would bid the florin up.

Keynes is often alleged to have said, that “every policy maker is the victim of a dead economist”. At the end of this paper, one is left wondering why it takes so long to economists to digest the heritage of deceased policymakers.

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### ***Data appendix.***

Forward markets in foreign exchange facilitate transactions in goods and securities across the borders if at least one of the countries has fluctuating exchange rates. Thus, there were less reasons for futures to develop among the German reichsmark, the French franc, or the British pound, because all were on essentially fixed exchange rates even prior to the advent of the gold standard. However, among the mark, on the one hand, and such currencies as Austria-Hungary's florin and the Russian ruble this need did arise, insofar as Germany was both Russia's and Austria-Hungary's most important trading, and perhaps financial, partner, with both the florin and the ruble effectively on a flexible exchange rate until the 1890s. Fluctuations of the florin-reichsmark exchange rate before 1896 were very large.

In Vienna, as in other European markets, there was thus also a forward market in general securities. These forward transactions were to be settled – liquidated – mostly at the end of the month, named after the French word «*liquidation*». As emphasized by Haupt [1894], international arbitrage in securities was a routine operation in late-nineteenth-century Europe. It rested on a borrowing on a given security in a market (say Berlin) where the corresponding rate (known as «report») was low and lending on a market (say Vienna) where the rate was high. Doing so, however, involved an element of risk due to the possibility of exchange fluctuations. Obviously, the only way to be covered against these fluctuations was to have a forward exchange market that would clear at the same dates as the markets for forward securities, and thus enable one to perform a «true» (i.e. risk free) arbitrage. It is thus not surprising to find that, along with the «*ultimo*» quotes for general securities there were also in Vienna «*ultimo*» quotes for German marks and Russian rubles, in addition to the «spot» (or «per cassa») rates. Interestingly, this provides a rationale for the development of the forward markets that points to the combined influence of floating exchange rates and international financial arbitrage.

In order to cover merchants' risks, as well as risks associated with arbitrage on securities denominated in foreign currencies, large markets for future delivery of foreign currencies evolved in

Central Europe in the last third of the nineteenth century with traders specializing in the business (Lotz, 1889, 1279). Gulden-mark futures came into being, probably well before 1876 when published data first appeared (Einzig, 1937, 31-38). Indeed, it is noteworthy that the official quotation of forward mark rates in Vienna began in 1876, precisely in a year of especially large exchange rate volatility (Flandreau and Komlos, 2001). There were also forward markets in Vienna in other major currencies, but these were small and were not quoted in the official publications. (An exception was the 20 French Franc gold piece and the rubel which were quoted forward.) (Federn, 1910a, 164). The forward market in rubels first came into being in Breslau and Königsberg and subsequently in Berlin (Schulze-Gävernitz, 1899, 503-4), and futures in rubels were also traded in Vienna (Knapp, 1905, 252). Most importantly, and apparently unlike its Russian counterpart, the Austrian forward exchange market survived the stabilization of the florin in the 1890s.

Our exchange rate data were collected from the Wiener Börsekammer Coursblätter, in the archive of the Wiener Börse A.G., Strauchgasse 1-3, A-1014 Vienna, Austria. Schneider et al. [1990] and Schneider et al. [1993] have spot, but not forward rates. Forward rates were also published in the Wiener Zeitung as well as in the Neue Freie Presse. A comparison among the three sources indicated only marginal deviations. The Coursblätter is more systematic in that it gives a series of quotes, day high, day low, mid day, closing. Closing quotes were the most comprehensive and were thus the ones we collected. Spot (per cassa) exchange rates with Germany are reported from January 1870 until the Summer of 1914 in all three sources. Until February 1873, though, they are reported in florins per 100 marks bancos, the Hamburg unit (Hamburg was Germany's prominent foreign exchange market until Germany's monetary unification which shifted business to Berlin). Rates switched to German marks in February 1873 with the advent of the new German currency. In order to obtain a homogeneous series in florins per marks, we divided the quotes in Mark Banco by 1,5. The sources report both « Geld » and « Waare » rates. « Geld » prices were the bid price, the price at which people were willing to buy foreign exchange and offering local money. « Waare » was the price at which people were offering to sell the "goods" (in this case Marks). Forward rates are available from November 1876 until June 1889 under the heading "Liquidations Course", but no distinction was made between bid and ask rates. From July 1889 onwards, the forward rates were quoted as «Ultimo», and the distinction between bid and ask rates appeared. Moreover, from January 1900 quotes are given in Crowns per 100 mark and the quotes were divided by 2 in order a homogeneous series.

Given that forward rates are quoted for the end of the month (liquidation date) the best date to collect the figures is the first day of the month *after* the previous liquidation. When this was a bank holiday, we collected the next available quote. Three observations need special mention:

- ? Spot quotes were not reported for 2.10.1871, and we used the rate for 3.10.1871.
- ? 2.2.1911, the value for the spot rate: 117.800 is clearly a typographical error (because bid price exceeded the ask price) and we used instead 117.300, as the obvious value. We would have gotten the same results if we had used midday values.
- ? For 01.04.1913 we use midday values for both spot and forward rates, because end-of-day value is unavailable for forward rate.

We then constructed two series. A series of average bid/ask rates ( $(\text{Geld}(t)+\text{Waare}(t))/2$ , 1876 :11-1914 :7) and a series of bid rates (1889 :7-1914 :7). The database (available from the authors upon request) consists of florin/mark exchange rates (number of florins for 100 marks) and spans the period 1870:1-1914:7 (spot rates) and 1876:11-1914:7 (forward rates). German interest rates were collected from The Economist, Der deutsche Ökonomist, and the Frankfurter Zeitung.





Figure 1. The Florin/Mark Exchange Rate: Florins / 100 Marks, 1870-1914

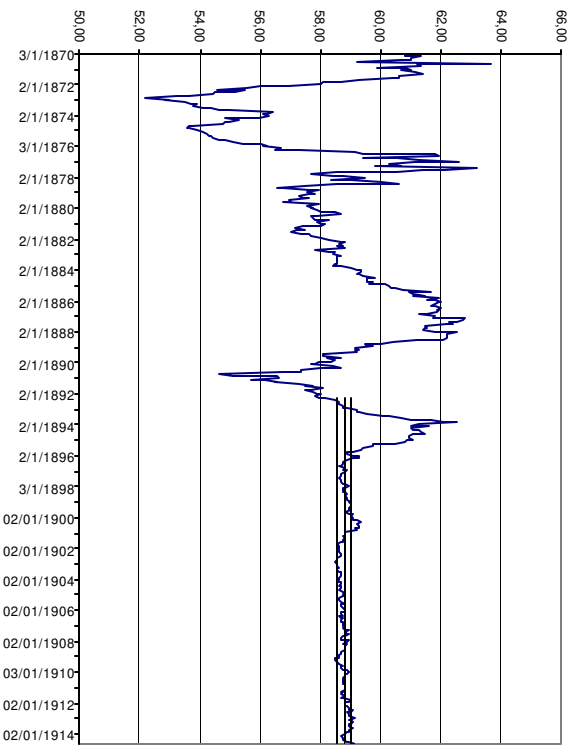


Figure 2. 100% credibility tests, 1896-1914

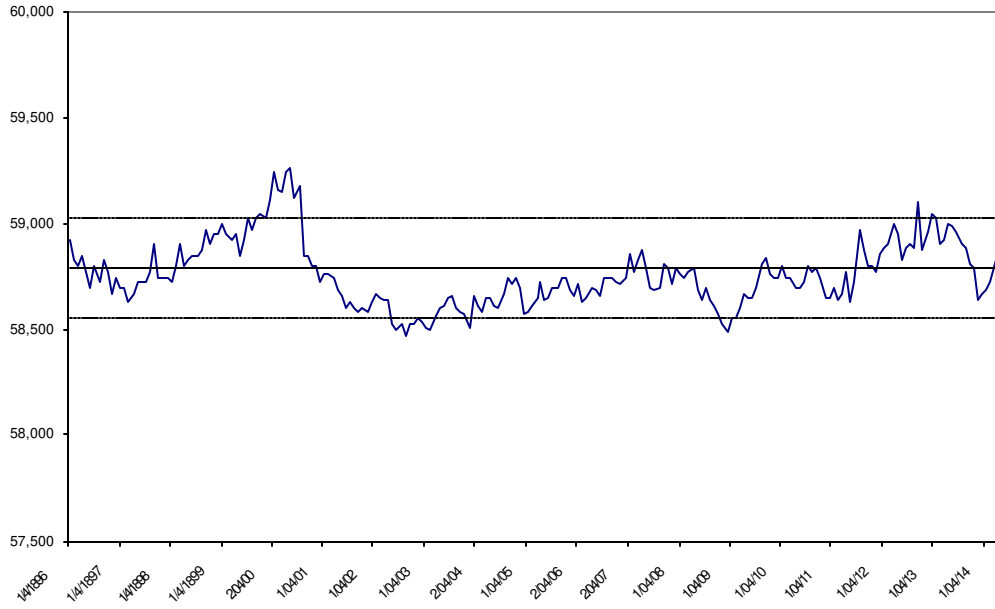


Figure 3. The basic TZ model: Predicted relation between the Exchange Rate and the Interest Rate differential

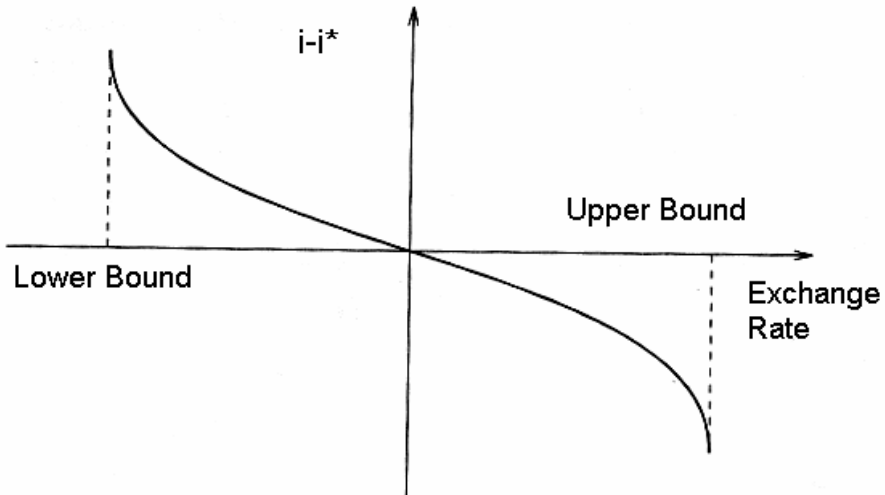


Figure 4a. Florin/Mark 1896:4-1914:  
Market Interest Rate Spread (%) in Terms of Percentage Deviation from Parity

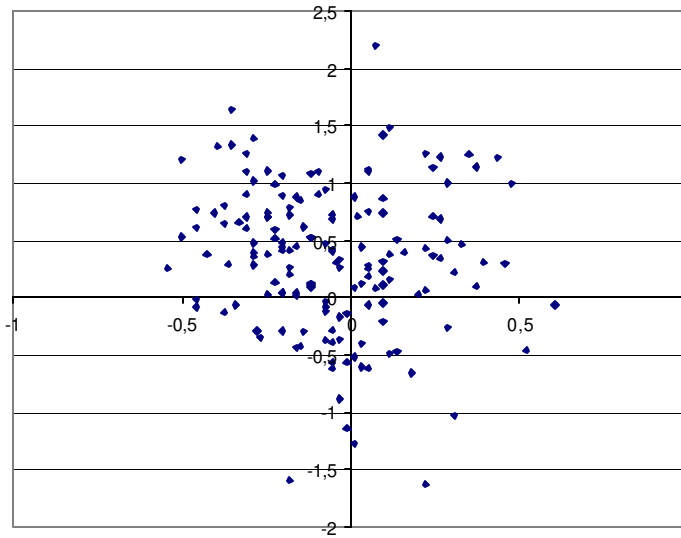


Figure 4 b. Franc/Pound, 1880-1914:  
Market Interest Rate Spread (%) in Terms of Percentage Deviation from Gold Parity

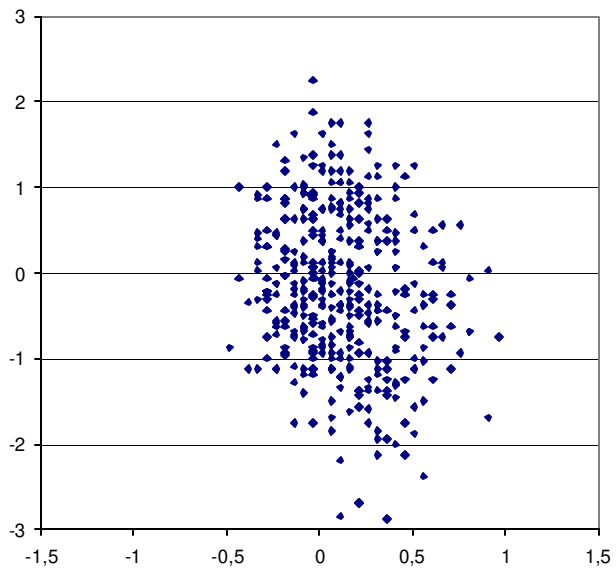
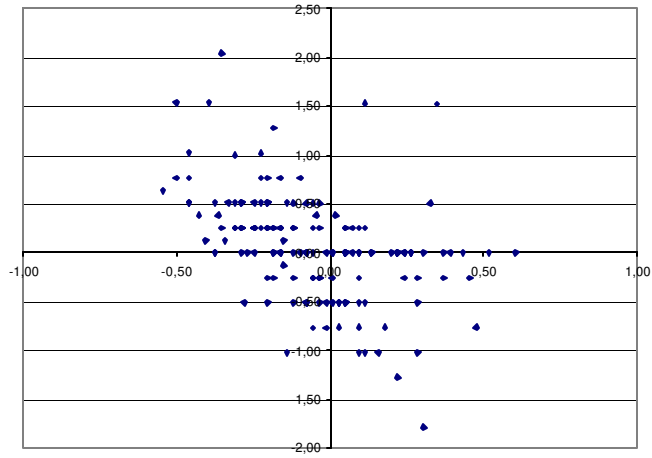


Figure 5. Annualized “expected” exchange rate change (%)  
in terms of exchange rate deviation from parity (%) (1901:8-1914:8)



Source: see text

Figure 6a. Covered interest parity (annualized expected x-rate change in terms of interest differential):  
market rates  
(units: percentage. Blue: 1876-1895. Pink: 1896-1914)

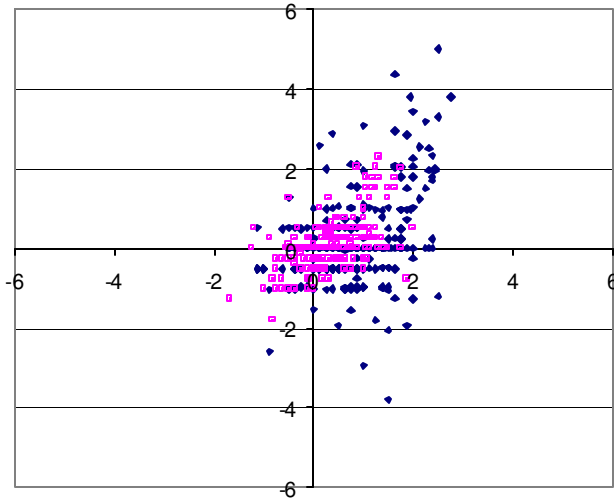


Figure 6b. Covered interest parity: bank rates

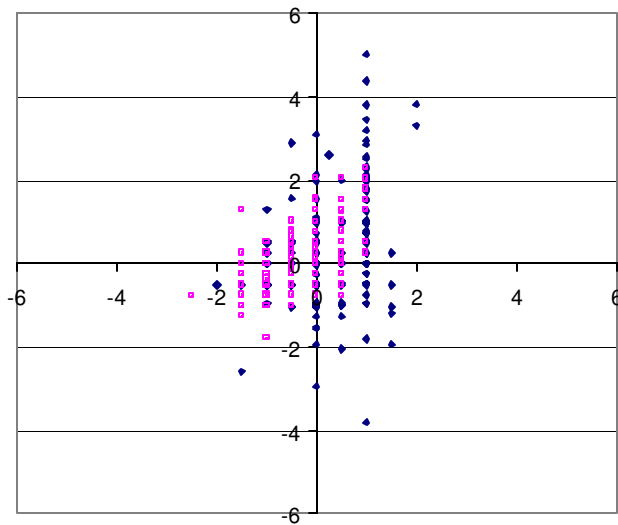




Figure 7 : Spreads of Spreads:  
Expected depreciation minus interest differential and arbitrage costs  
(1876:11-1914:8)

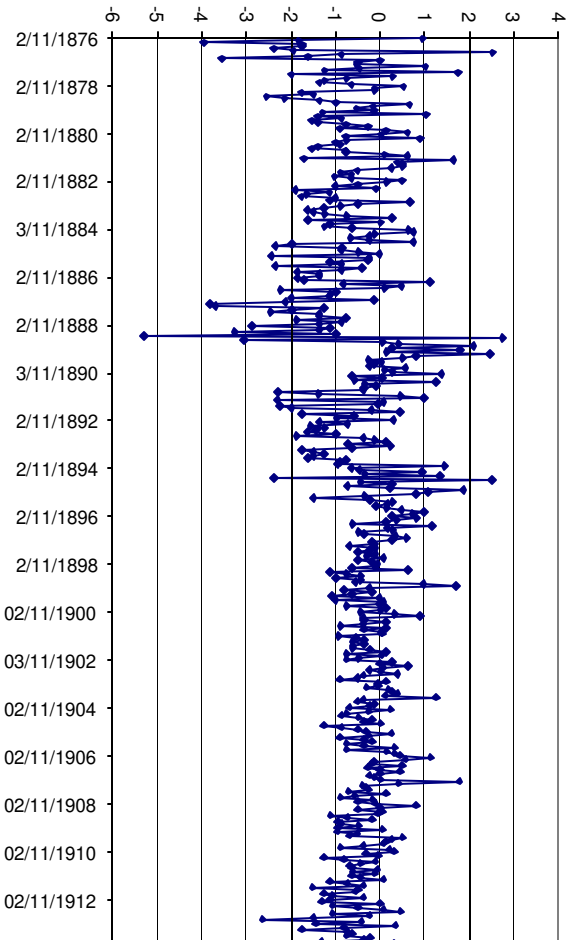
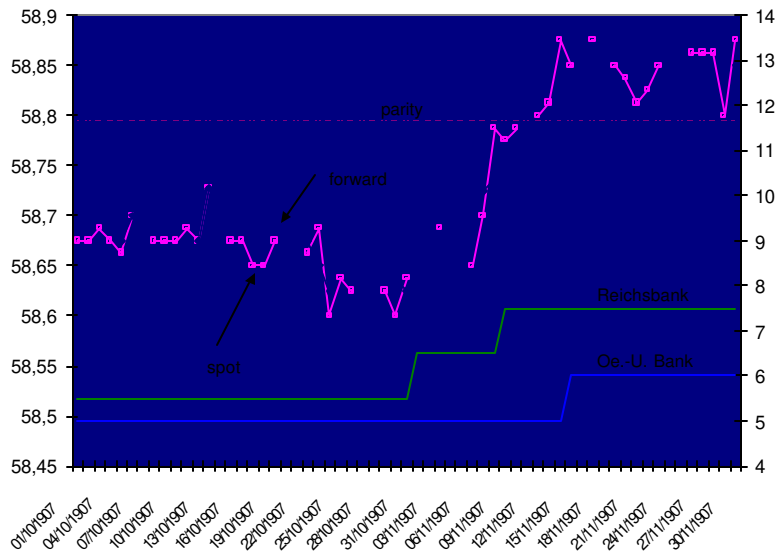


Figure 8. The crisis of 1907:  
exchange rates and official interest rates



Source: see text

## Endnotes

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<sup>1</sup> . According to Keynes the leeway for monetary policy was a function of the spread between the gold points: “... the degree of separation between the gold points is a vital factor in the problem of managing a country’s currency and ought to be the subject of a very careful decision... I believe that there is room here for a reform of real importance [...] This would permit temporarily the maintenance of materially different short money rates in the two centres.” For a reprint of Keynes’ analysis along with a discussion of its relevance to the target-zone literature see Eichengreen and Flandreau [1997].

<sup>2</sup> Determining the extent to which Keynes was directly inspired by the Austro-Hungarian precedent should be of interest to the historians of economic thought, but is outside of the purview of this study. We do not find an explicit reference to the Austro-Hungarian case in Keynes, who discusses instead the French experiment with « gold devices ». But it is probable that he knew very well of the policies developed and practiced in Vienna at the turn of the century. Keynes was a City expert as much as an economist, and the close connections between Viennese and London institutions before and after WW I were reinforced by the exodus of numerous Austrian financiers to London in the inter-war period. Moreover, the Austrian discussions on this issue had reached the British public very early on, through von Mises’s publication in the Economic Journal (Von Mises [1909a]), an article with which Keynes would no doubt have been familiar. Finally, Keynes was an admirer of Knapp’s *Theorie des Geldes*, of which a large part was devoted to describing and praising Austro-Hungarian policies (see Hodgson [2001]). In other words, there were too many similarities between Keynes’ proposal pertaining to target zones, and the Habsburg experiment to have been merely coincidental. According to Einzig: «There is, however, no reason to believe that the devices which were applied successfully on a small scale in Vienna could not be applied with equally successful results in London or other centers on a much larger scale » (Einzig, 1937, p. 339).

<sup>3</sup> For the political economy of this question, see Michel (1976) and Flandreau (1999).

<sup>4</sup> Probably through informal contacts between bank officials and the financial community: see e.g. Mises [1909] or Einzig [1937].

<sup>5</sup> It would take the 1992 and 1993 ERM crises for modern policy makers to relearn this simple lesson.

<sup>6</sup> There was a debate on the exact form of foreign exchange interventions. Von Mises insisted that all interventions were on the spot market. But Federn, with whom Einzig sides, claimed that these were complemented by forward interventions. However, our perusal of board minutes did not find references to forward interventions. Archive of the Austrian National Bank, Vienna, Austria. Protokoll No. 3612/15, October 24, 1907; 3849/15, November 9, 1907; 4207/15, November 28, 1907. , rather than through outright gold convertibility, as some other central banks of the time did. Since 0.4% roughly corresponded to the cost of shipping gold between Berlin and Vienna, Austro-Hungarian authorities were said to be shadowing a gold standard.

<sup>7</sup> . For more on credibility tests, yielding similar results, see Flandreau and Komlos [2001] and Jobst [2001].

<sup>8</sup> Walther Federn (unsigned), Die Zeit, 23 August 1907, reiterated in numerous editorials in Der oesterreichische Volkswirt, i.e., July 17, 1909. For a complete list of dates see Einzig, 335; see also, Federn, (1910b, 666). In the 1910 article Federn referred explicitly to the need to cover exchange-rate risk by selling forward marks.

<sup>9</sup> . Einzig, [1937], p. 332-3.

<sup>10</sup> . A third hypothesis, which we will leave aside, is that the currency band has exogenously given bounds. While essential to get a closed form analytical solution to the model, this assumption is more cosmetic in that the key predictions of the model which we consider here are independent of it.

<sup>11</sup> . We realize that in Bertola and Svensson [1993], as well as in later applications of their framework, the devaluation risk is exogenous from exchange rate location. But this, we feel, is precisely one serious limitation of their approach.

<sup>12</sup> The one exception being Koppl and Yeager [1996] who focus on inefficiencies in the ruble/mark forward market and argue that these can be attributed to interventions by the Russian government. Notice that the kind of efficiency test we consider here (known as “strong form tests”) must be distinguished from weak form tests, for which some studies for the gold standard period are available (e.g. Goldman [2000]). Weak form tests consider whether in  $x_t = \beta \cdot x_{t-1} + \epsilon_t$ ,  $\beta = 1$ .

<sup>13</sup> This relation can alternatively be tested in levels. Results are virtually the same. The main advantage of working with logs at this stage is that it prepares the ground for the regressions in the next section which rely on rates of change and thus *require* working with logs.

<sup>14</sup> As explained in the appendix, we have two series for both the spot and forward rates. The average “bid-ask” series spans 1876:11 to 1914:6. The alternative bid series spans 1889:7 to 1914:6. This is the case because before 1889:7 we only have the average forward rate – so we can only use the average spot rate as well. Since taking into account the average bid-ask spread introduces some additional (albeit marginal) noise in the series, there are reasons to prefer the Geld series which on the other hand is shorter. When they overlap they yield virtually identical results.

<sup>15</sup> Yeager [1968]. Since it is difficult to point to a specific month we conveniently decided to use as a break point August of 1889 as it coincided with the beginning of the bid forward series.

<sup>16</sup> The new parity was leaked to the market between April 18 and 23<sup>d</sup>, see Flandreau and Komlos [2001]. It was not until 1893, however, that the law was formally ratified by the Austrian and Hungarian parliaments.

<sup>17</sup> Since the band was informal, there was no announcement made. However, very much in the same way government officials had leaked the new parity, it is probable that an informal announcement was made. Contemporaries refer to a policy that would have began in early 1896. Our data shows that the exchange rate reentered the  $\pm 0.4\%$  band in April, and this motivates our choice.

<sup>18</sup> As can be seen, in some cases one cannot reject the null of market efficiency. But this is due to the low significance level of parameters: while  $H_0: \beta = 1$  cannot be rejected, one cannot reject  $H_0: \beta = 0$  either.

<sup>19</sup> . This is also in contrast to findings reported in the recent literature for more recent experiments (MacDonald 1988, de Grauwe 1989).

<sup>20</sup> Estimates were made also by dividing the period 1901-1914 into sub periods. This did not introduce any changes in the estimates of  $\beta$ . Obviously, once established, market efficiency was maintained unchanged until the outbreak of World War I.

<sup>21</sup> This is quite intriguing in view of the modern consensus against the efficiency hypothesis, and particularly so since according to Federn (1911, 1388) the Austro-Hungarian Bank began a policy of intervening in the forward market at least by the financial crisis of 1907. This runs quite counter to the popular view that one possible source of market inefficiency might be government intervention on the forward market (Fama [1984], De Grauwe, [1998]).

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<sup>22</sup> This point posed practical men of finance against such theoreticians as von Mises, who argued that the existence of a forward premium did not prevent arbitrageurs to put their money where the higher interest rates prevailed (1909b). Obviously, von Mises was overlooking exchange-rate risks, unlike practical men.

<sup>23</sup> All values except column 3 are lower than critical value at 5%. We can accept the null hypothesis that lagged variables are jointly insignificant. The only Granger causality value larger than this is the one obtained for column 3 in Tables 4a and 4b.

<sup>24</sup> In column 4 none of the estimated coefficients of the lagged values of the other variable (bold faced) are significant. In contrast, in column 3 the majority of coefficients are non significant. This is very powerful evidence that the interest differentials were driving the forward premium.

<sup>25</sup> This conclusion is in line with the recent « fear of floating » literature according to which country may prefer to peg when they realize that floating does not provide them with the flexibility they need. Bordo and Flandreau [2001] show with a large sample of countries that the stabilization of currencies on gold standard currency bands was strongly associated with an increase in financial depth, which can be interpreted as a proxy for financial development and market efficiency.