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# Working Papers

## HOW TO RUN A TARGET ZONE? AGE OLD LESSONS FROM AN AUSTRO- HUNGARIAN EXPERIMENT

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## HOW TO RUN A TARGET ZONE? AGE OLD LESSONS FROM AN AUSTRO-HUNGARIAN EXPERIMENT

### Abstract

This paper considers what we argue was the first experiment of an exchange rate band. This experiment took place in Austria-Hungary between 1896 and 1914. The rationale for introducing this policy rested on precisely those intuitions that modern target zone literature has recently 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. In other words the episode provides us with 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 flexibility? 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. This enables us to understand why Austro-Hungarian policy makers were so upbeat about the merits of exchange rate target zones. We believe that these findings shed a new light on the economics of exchange rate bands.

JEL Classification: F31, N32.

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## Introduction

Economic concepts are supposedly like modern Athenas, we often think of them as being born fully mature and armed. Economists generally pay insufficient attention to the archeology of ideas. These are, nonetheless, significant not only in and of themselves, but also insofar as they often shed important insights on our current understanding of policy issues (Blaug 2001). We consider here an early experiment with an exchange-rate band implemented in 1896 in the Austria-Hungary before World War I, and which lasted until WWI. This experience is relevant for our understanding of the impact of exchange-rate arrangements on monetary policy. The reason is, that the Austro-Hungarian exchange-rate regime was explicitly designed as an early version of what has become known as a “target zone”, and that unlike more recent attempts it was extremely successful. This policy was described by one of its main architects, Count Bilinski, who was then governor of the Bank, as “original”, “excellent”, and very useful in insulating the currency from foreign shocks, while also providing for exchange rate stability. According to Bilinski, this “innovation” in monetary policy had enhanced the bank’s reputation greatly, and brought it prestige not only in the financial markets but within academia (Federn, 1911, 1388). Leading contemporary economists, such as Knapp [1905], saw these policies as the archetypal application of the new theories in vogue at the time, according to which a currency derives its value of what market thought of the issuing government – in modern language, of its credibility. This, they argued, opened the way to the emergence of active monetary management, of which the Austro-Hungarian monetary authorities were described as a pioneer.

For contemporary macroeconomists these views have a definitely modern ring. They echo Krugman’s model of an exchange-rate band (Krugman 1991) which is a formal description of how a fluctuation band (target zone) works in theory. The model’s fundamental insight is that, compared to free floats, target zones are «inherently stabilizing»: as the exchange rate approaches one of the bounds, its responsiveness to monetary shocks declines, for agents anticipate the counteracting effect of eventual foreign exchange interventions by the central banks. Subsequently, Svensson [1992, 1994] emphasized that the main advantage of such a system was that it enables monetary authorities to refrain from tightening monetary policy when foreign interest rates increase without suffering excessive exchange rate depreciation (and vice versa), because agents expect an eventual

stabilization of the currency. The central bank gets a measure of insulation when domestic and foreign conditions differ – just as Austro-Hungarian monetary authorities thought.

Svensson attributed the origin of this notion to Keynes [1931] who argued, in a now famous part of his Treatise on Money that there was a correspondence between the distance within the «gold points» (as exchange rate bands were known under the gold standard) and the degree of short-term policy autonomy<sup>1</sup>. Yet, as Einzig [1937] recognized, Keynes' insight itself had its roots in the policies of the central bank of the Austro-Hungarian monarchy. These policies had emerged as a response to the dilemma of trying to find some way to secure exchange rate quasi-fixity, while also getting the kind of protection from foreign exchange-rate shocks that was thought to have existed in the past behind the “Chinese wall” 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 strict gold standard, 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>2</sup>

The practical solution found to this problem was to stabilize the currency from 1896 onwards within an informal currency band whose exact size authorities never specified. Observers put it around +/-0.4%, a figure that more or less corresponded to the shipping charges for bullion between Vienna and leading financial centers such as Berlin or London. Austria-Hungary was, thus, said to “shadow” the gold standard. This was achieved through discretionary foreign exchange intervention when the exchange rate departed “too much” from the central parity, rather than through gold convertibility, as some other central banks of the time did.<sup>3</sup> In effect, compulsory convertibility, although constantly on the mind of subsequent finance ministers was never introduced.

Contemporary authors, such as Walther Federn (a practicing economist and founding editor (1909) of the Viennese financial weekly, Der Österreichische Volkswirt), explained how stability and flexibility were mutually reinforcing in strikingly modern terms, that anticipate recent analyses (Federn, 1910b, 662; Federn, 1911, 1391; Federn, 1912).<sup>4</sup> When interest rates were higher in Berlin than in Vienna, the bank could let the exchange rate depreciate as a substitute to raising the interest rate. The resulting exchange rate depreciation needed not have been large, because it triggered stabilizing expectations of eventual recovery: „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>5</sup> As a consequence, the Austro-Hungarian economy was not completely hostage to tight monetary policies in distant parts of the globe (table 1).<sup>6</sup>

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	1.5
1896-1913	27	1.5

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

While virtually forgotten today, this precedent is well known to inter-war economists. Einzig's famous book, *The Theory of forward exchange* (1937) (not incidentally dedicated to Keynes), accepts Federn's views without reservations: "To discourage the outflow of funds", Einzig wrote "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." Moreover, Einzig suggested explicitly that there was a clear parallel between Austro-Hungarian policies and Keynes' intuitions: "The device of allowing the spot exchange to depreciate [...] closely resembles Mr. Keynes's proposal for the widening of the margin between gold points. And the circumstances of its application in 1907 and on other occasions are very similar to those in which Mr. Keynes claims that his proposed measures would be beneficial, i.e. when the weakness of the currency is due, not to fundamental disequilibria or a sweeping wave of distrust, but solely to the situation in foreign financial markets" (Einzig 1937, 332-3).<sup>7</sup>

Thus, the Austro-Hungarian precedent was the first experiment with an exchange-rate target zone, designed according to "modern" principles. Unlike its modern counterparts, however, it was one that observers deemed successful. We argue that studying it illuminates current discussions of the issue. We show that while the 1990s debate over target zones provided a useful analytical framework, it also confounded the matter somewhat by focusing almost exclusively on Europe's ERM. The ERM lacked credibility and its students concluded that the possibility of a trade-off between exchange rate stability and monetary policy autonomy rested solely on the monetary

authorities' ability to establish credibility. The findings of this paper suggest, in contrast, that this widely-held conclusion is incomplete. On the basis of newly collected (forward and spot) foreign exchange and interest rate series we carefully gauge the various hypotheses that are at the heart of the modern target zone model. This leads us to identify a new microeconomic channel which has been neglected in the modern literature: in particular, we show that the introduction of a target zone may change the very quality of expectations. This channel, through which target zones can further be stabilizing, and which does open the way to the policies described in theory Keynes-Krugman-Svensson and applied in practice in Austria-Hungary has been neglected in the recent literature. Moreover, we show that the existence of arbitrage costs render the standard test of the target-zone model basically inappropriate: due to the existence of transaction costs that play a large role over the short term horizon of monetary management, it is insufficient to consider whether there is a negative correlation between interest rates differentials and the spread between the exchange rate and parity. To tackle this problem, we develop an alternative methodology, that sheds light on the root of Austro-Hungarian policy successes, and could in effect be used to study any modern experience.

The remainder of the paper is organized as follows: Section I reviews the building blocks of TZ theory. Section II describes the workings of pre-1914 Viennese exchange markets and analyses their efficiency with and without a band. Section III explores Covered Interest Parity in order to document arbitrage efficiency and provides a new methodology to assess the performance of a given target zone. We conclude with lessons for both economic theory and economic policy.

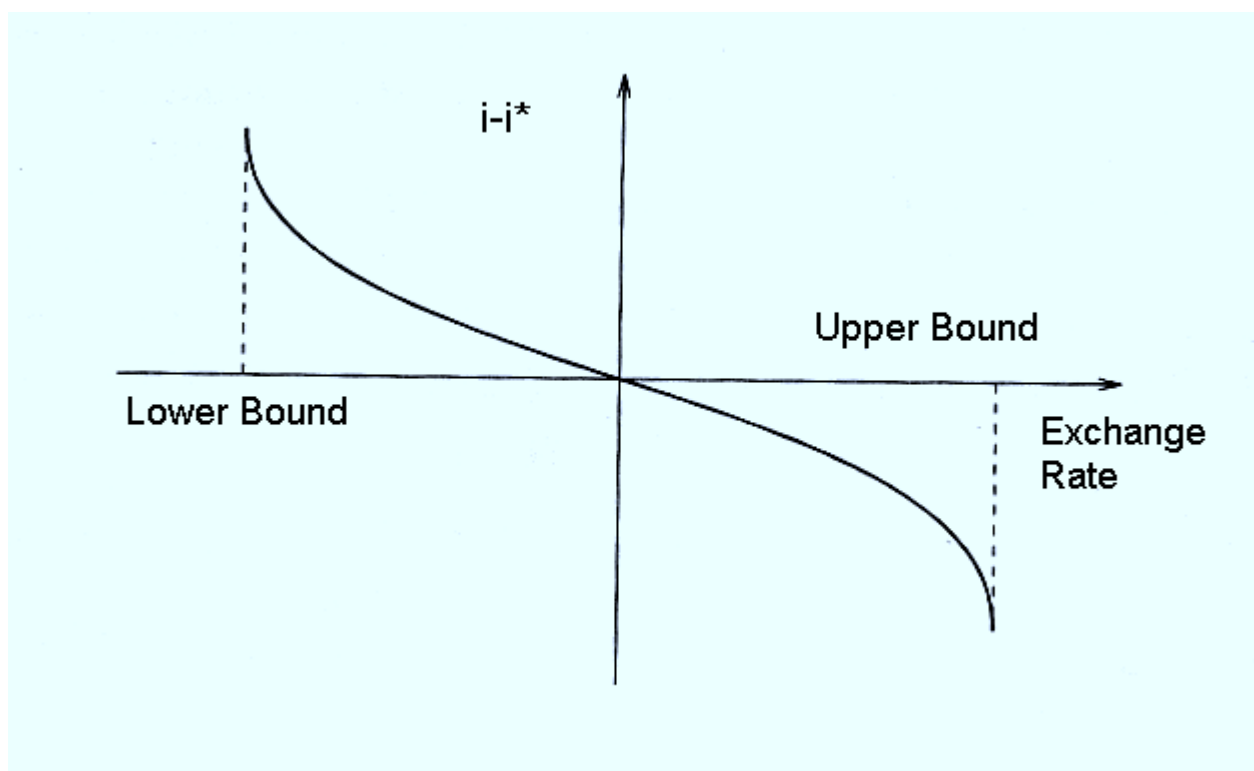
### ***Section I. Does credibility “buy” autonomy? Some theory and a puzzle***

#### *a) Theory*

Modern TZ theory posits, first that fundamentals (money supplies) determine exchange rates so that exchange rates can be monitored through interventions on fundamentals (non sterilized foreign exchange interventions that adjust money supplies when needed). Second, it presumes that markets are efficient, from which follows that in the absence of arbitrage costs, interest differentials between countries are proportional to the spread between spot and forward rates (known as the forward premium) and that the forward premium is an unbiased predictor of actual exchange rate changes. From these two axioms follows a key prediction: interest rate differentials should be inversely related to location of the exchange rate within the band. The intuition is that 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. In other words, a measure of mean reversion is built into such a bounded process and rational agents should realize it: as a result, they should accept a lower interest rate for a currency that is momentarily weaker, (because of expected gains on its future appreciation), thereby giving the monetary authorities the flexibility of not intervening in the spot foreign-exchange market without using interest-rate increases as an adjustment tool (Figure 1).

Figure 1. The basic TZ model: Predicted relation between the Exchange Rate and the Interest Rate differential



## 2) Empirical Evidence

Research on contemporary experiences have basically rejected this model (see Svensson [1992] for an early survey). Essentially, the focus on the recent ERM experience, and more specifically on the Franc-Mark relationship led to the conclusion that whenever the exchange rate depreciates towards the edge of the band, the interest rate of the weaker currency rises above that of the stronger one. Thus, exchange rate depreciation has been associated with higher, not lower, domestic interest rates, in sharp contrast to the model's predictions. However, this was because in the ERM a



depreciation towards the edge of the band was interpreted as a signal that a devaluation could be anticipated. Therefore, a consensus emerged that the ERM must have lacked the crucial ingredient of credibility.

More recently, however, a number of papers provided a partial rescue of the target-zone model, and reinforced at the same time the notion that the ERM lacked credibility. The examination of the record of the stronger members of the classical and inter-war gold standards, whose policies involved much less frequent devaluations resulted in more encouraging assessment of TZ regimes (Bordo and MacDonald [1997], Hallwood, MacDonald, and Marsch [1998], Bordo and MacDonald, [1999], Hallwood, MacDonald and Marsch [1998]). Yet, the substitutability between exchange rate stability and policy autonomy remained rather modest. For example, Bordo and MacDonald's [1999] tests on the relationship between exchange rates and interest rate differentials before WWI only found two out of the three relations under study in agreement with the theory: while UK-Germany and UK-France, yield a negative relation between interest differentials and exchange rates the slope is positive for France-Germany. Moreover, as is apparent in Figure 2a, this relation, even when correctly signed, is not significant. A similar chart drawn for Austria-Hungary and Germany for 1896-1914 does not seem to give a more convincing picture.

Figure 2 a. Franc/Pound, 1880-1914:  
Market Interest Rate Spread (%) in Terms of Percentage Deviation from Gold Parity

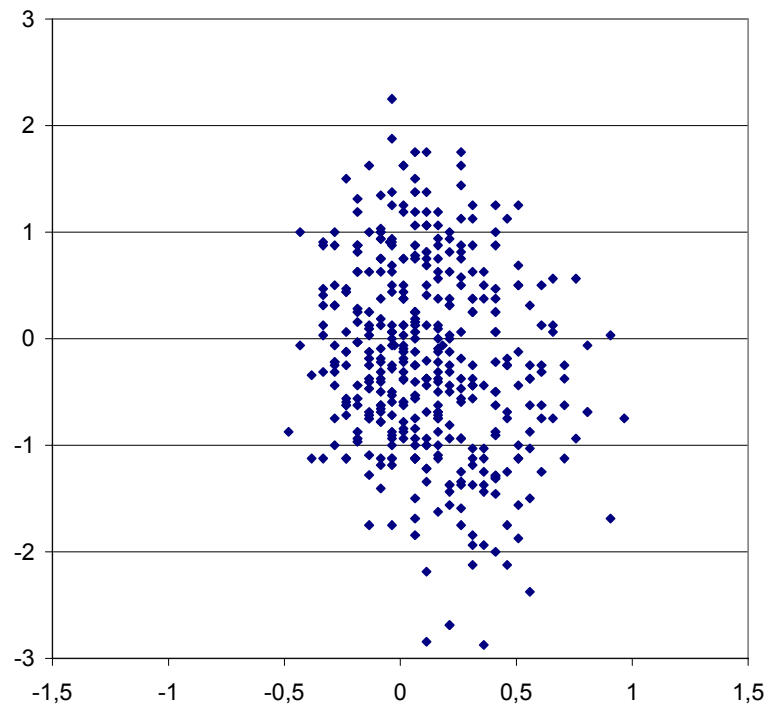
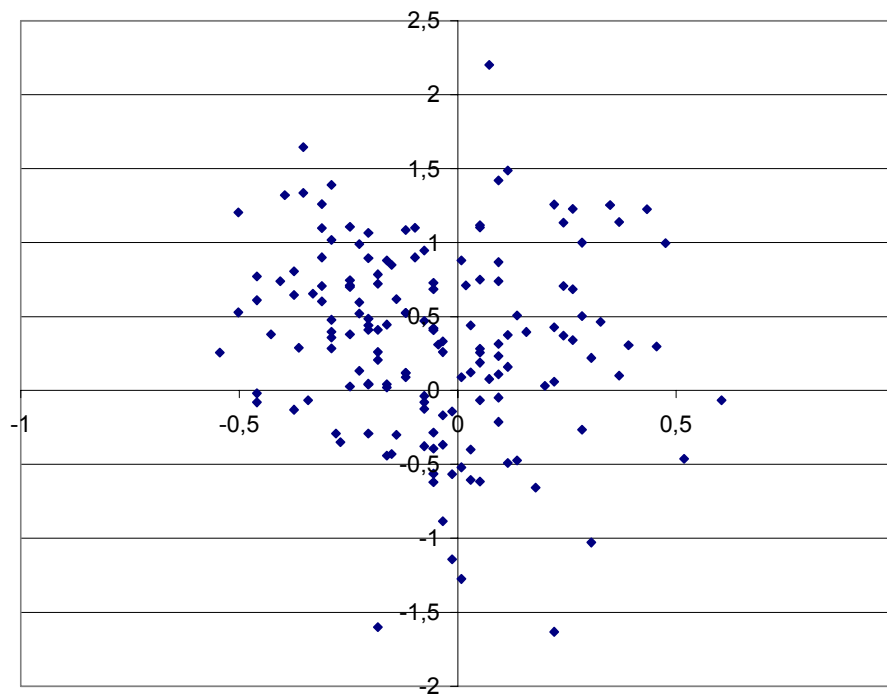


Figure 2b. Florin/Mark 1896:4-1914:  
Market Interest Rate Spread (%) in Terms of Percentage Deviation from Gold Parity



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 so modest and unreliable? Even the more ‘favorable’ results one obtains with data from the gold standard era could be interpreted as devastating evidence against the target zone model. 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?

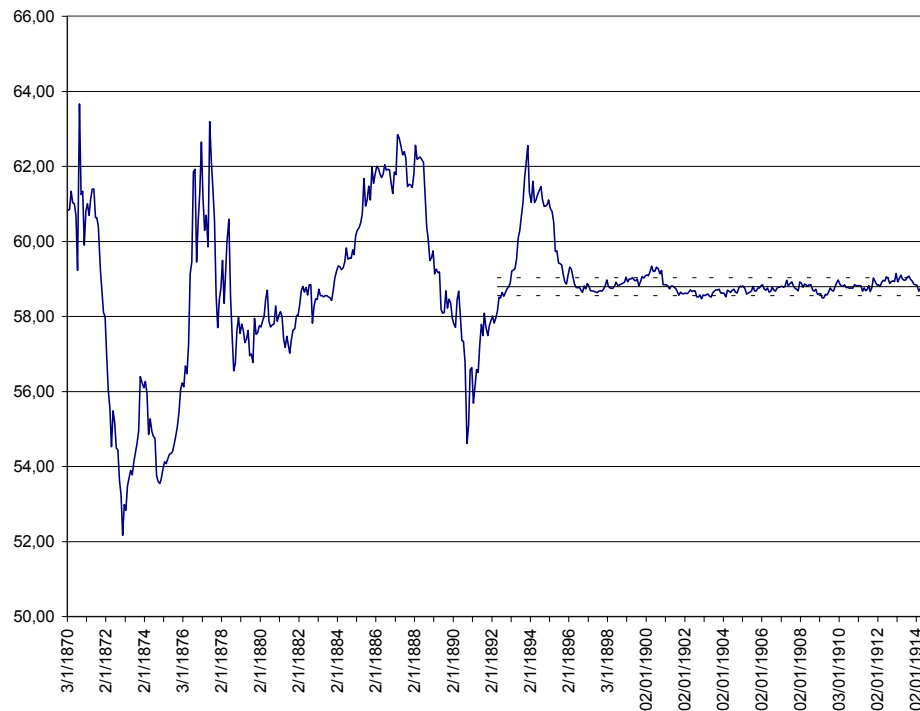
## ***Section II Foreign exchange market efficiency***

### *a) Early forward markets*

Unlike for other pre-1914 exchange rate regimes studied recently, Austria-Hungary had a well-developed market for forward exchange. The data required to document each of the hypotheses at the heart of the TZ model – covered and uncovered interest parity – are, thus, available. Before we proceed, however, a brief discussion of Vienna's foreign exchange market is in order.

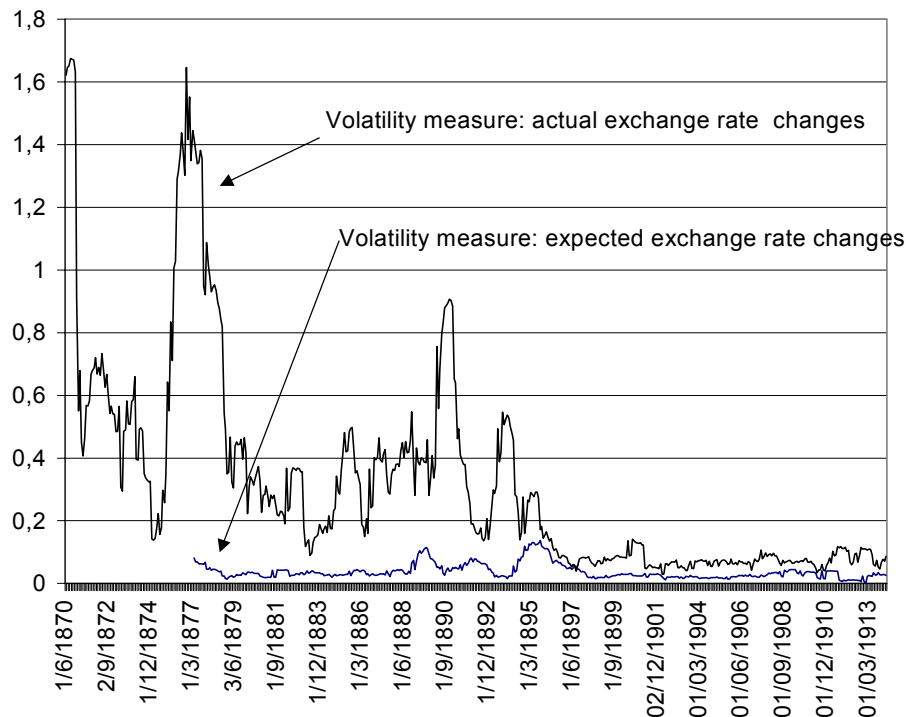
Futures in foreign exchange facilitate transactions in goods and securities across the borders if at least one of the countries has fluctuating exchange rates. Thus, there were less reasons for futures to develop among the German reichsmark, the French franc, or the British pound, because all were on 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 (Figure 3). In order to cover merchants' risks, as well as risks associated with arbitrage on securities denominated in foreign currencies, large markets in currency futures evolved in Central Europe in the last third of the nineteenth century with traders specializing in the business<sup>8</sup> (Lotz, 1889, 1279). Gulden-mark futures came into being, probably well before 1876 when published data first appeared (Einzig, 1937, 31-38).<sup>9</sup> Most importantly, the forward market survived the stabilization of the florin in the 1890s (see appendix for the construction of the data set).

Figure 3. The Florin/Mark Exchange Rate. Florins / 100 Marks, 1870-1914



A well known feature of forward rates is that they track spot rates rather closely (MacDonald [1989]): not much insight can be gained by plotting both series. By contrast, looking at the volatility of exchange rates and forward rates is informative. Figure 4 compares the volatility of the forward premium and that of actual exchange rate changes. This may be thought of, in first approximation, as a way to compare the volatility of predicted versus actual changes. The chart suggests that the stabilization of the florin after 1896 went along with a considerable reduction of the volatility of spot rates both in absolute terms and in relation to the volatility of the forward premium: one interpretation is that the transition to the florin's currency band implied much less uncertainty regarding future exchange rate changes, improving the information ratio between spot and forward exchange. In the next paragraph, we test this formally, and show that the adoption of the florin target zone also brought about a much greater predictability of future exchange rate changes.

Figure 4. Root of Average Squared Forward Premium and Exchange Rate Changes



*b) Testing for market 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>10</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 efficient, the forward premium should be an unbiased predictor of actual exchange rate changes:

$$s_{t+1} - s_t = \alpha + \beta(f_t - s_t) + v_{t+1}$$

where  $v_t$  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>11</sup> Efficiency in the forward market implies  $\beta = 1$ . (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>12</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:

- *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>13</sup> and 1892:5 to 1896:3 when the basis of the stabilization was decided but not yet implemented.<sup>14</sup>

- *The « target zone » period spans 1896:4 to 1914:6.*<sup>15</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 cast 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 and 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).

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>16</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>17</sup> Individual parameter estimates are found very near to the values implied by the EMH ( $\alpha=0$  and  $\beta=.99$ ), significance increases dramatically, adjusted  $R^2$  rise substantially, and the F-test leads us to accept unambiguously the null of market efficiency.<sup>18</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. Not only did variations of the forward rate become smaller, but they also became easier to predict.<sup>19</sup>

Table 2. Foreign Exchange Market Efficiency Tests :  $s_{t+1}-s_t=\alpha+\beta(f_t-s_t)+v_{t+1}$ 

Period	$\alpha$	$\beta$	Adj.R <sup>2</sup>	DW	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 <sup>-3</sup> (-0.42)	0.54 (0.89)	-0.8 10 <sup>-3</sup>	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  $\alpha=0$  and  $\beta=1$  accepted at 5%.

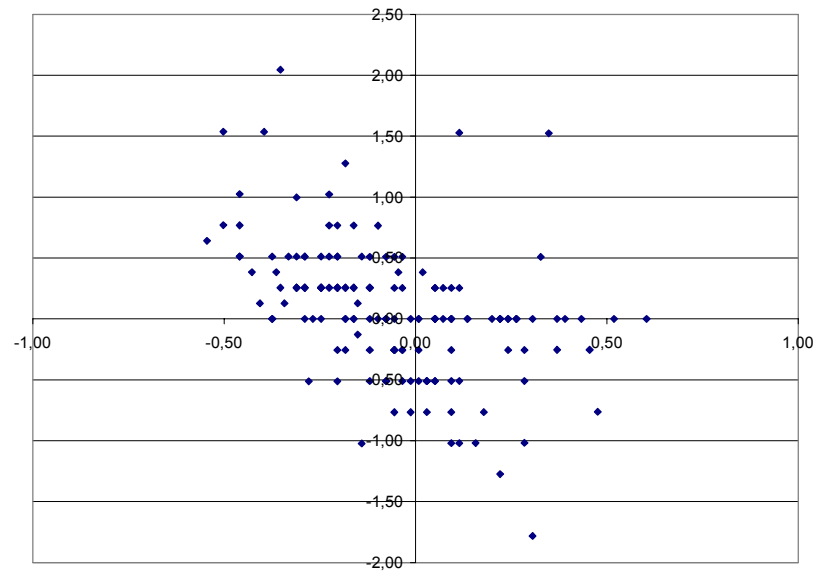
### c) Efficiency and mean reversion

The previous conclusion has far-reaching consequences for the relation between spot rates and the implicit rate of 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 within the band and the expected rate of depreciation. We offer two pieces of evidence to document that this was, indeed, the case.

First, an obviously negative relationship exists between the forward premium and the exchange rate during the period of the TZ exchange-rate regime, and it becomes even clearer to the "golden age" after 1901. This relation looks exactly as predicted by target zone models: it slopes downward. This is important because it shows that the credibility of the florin and the efficiency of the Vienna market for forward exchange improved at the very same time. This was far from being the case during the flexible exchange-rate regime (Figure 5b). The transition to the florin band thus induced fundamental transformations not only in the opinion market participants had of the florin, but plainly in the process through which this opinion was generated. In other words, the stabilization brought by a currency band might only partly come from stabilizing expectations regarding future interventions as suggested by the Keynes-Krugman-Svensson tradition: a currency band creates an environment that changes the very quality of expectations.

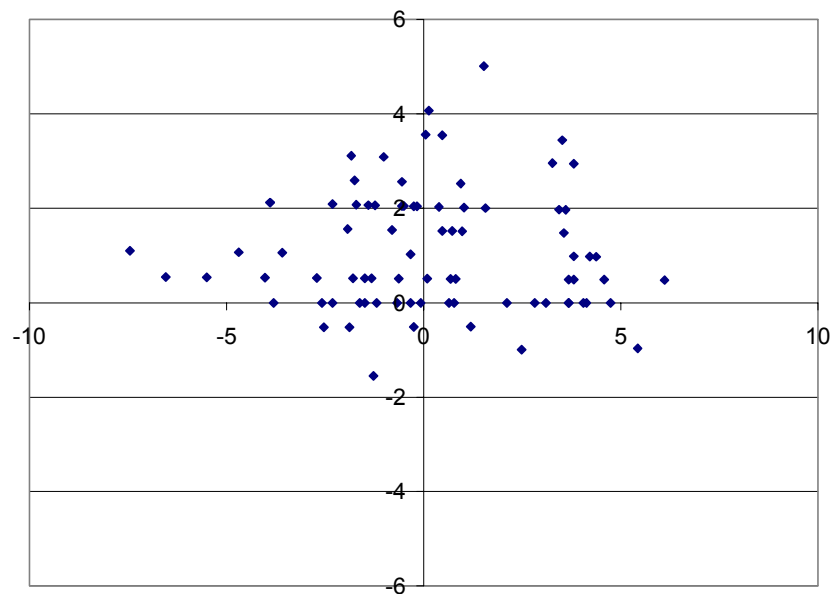


Figure 5.a Annualized “expected” exchange rate change (%) in terms of exchange rate deviation from parity (%) (1901:8-1914:8)



Source: see text

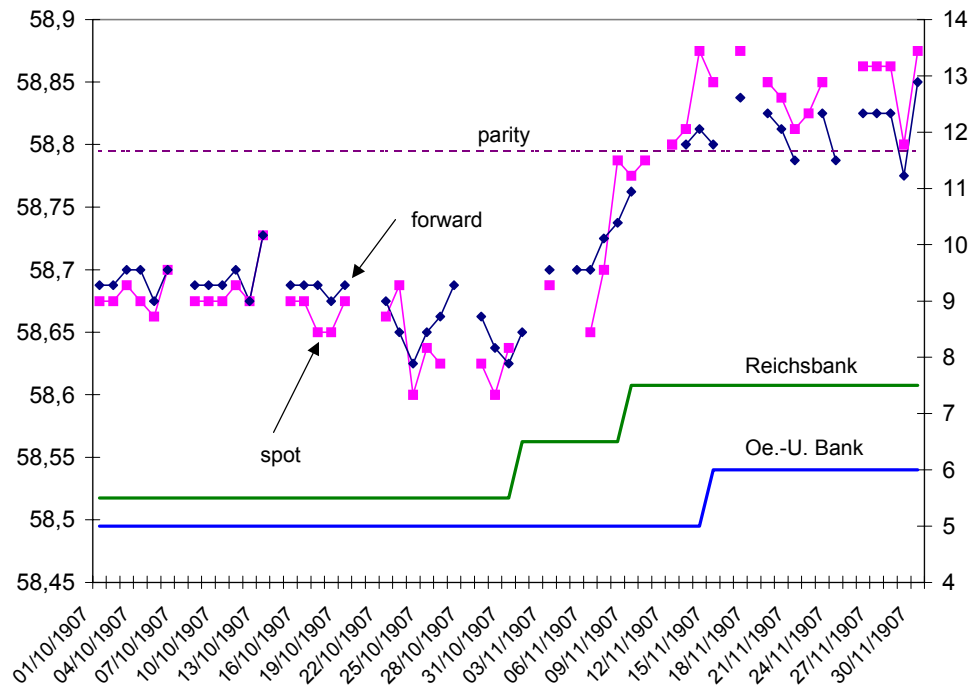
Figure 5.b. Annualized “expected” exchange rate change (%) in terms of exchange rate deviation from parity (%) (1889:7-1896:3)



Second, we can see that the TZ band played a particularly important role at times of international financial crisis such as that 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 masterpiece of monetary management and a direct consequence of the existing band (Federn 1909). Figure 6, derived from daily data, shows why contemporaries were enthusiastic. As can be seen the forward rate was systematically *above* the spot rate when the spot rate was *below* parity and vice versa. As the crisis developed, we see that the exchange rate depreciated while expectations of a future re-appreciation of the Habsburg currency began to feed in. And one implication of this was a widening of the spread between bank rates shown in the lower part of the chart. 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 market participants systematically expected the exchange rate to appreciate when it was low and to depreciate when it was high, on which the Austro-Hungarian monetary authorities could depend.

Figure 6. The crisis of 1907:  
exchange rates and official interest rates



Source: see text

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

At this stage, one might conclude that by the Summer of 1901, the florin's band had so much improved market efficiency that Austro-Hungarian monetary authorities could obtain some short-term interest rate autonomy, letting the exchange rate adjust. Why, then, is it that we find the pattern in Figure 2.b, 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<sup>20</sup>:

$$s_{t+1} - s_t = \alpha + \beta(f_t - s_t) + v_{t+1} \quad (2)$$

There were two interest rates in use at the time: the open market rate<sup>21</sup> and the official bank rate.<sup>22</sup> Insofar as they both have relative merits, we shall consider them in turn in our covered interest parity tests.<sup>23</sup> Figure 7a and b provide a crude test of equation 2, relying on market and official rate differentials. 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, regardless of the measure we use. Clearly, one cannot take covered interest parity for granted, which explains why the link between exchange rates and interest rate differentials is looser than the one between exchange rates and expected exchange-rate changes.

Figure 7a. Covered interest parity (annualized expected x-rate change in terms of interest differential): market rates  
(units: percentage. Blue: 1876-1895. Pink: 1896-1914)

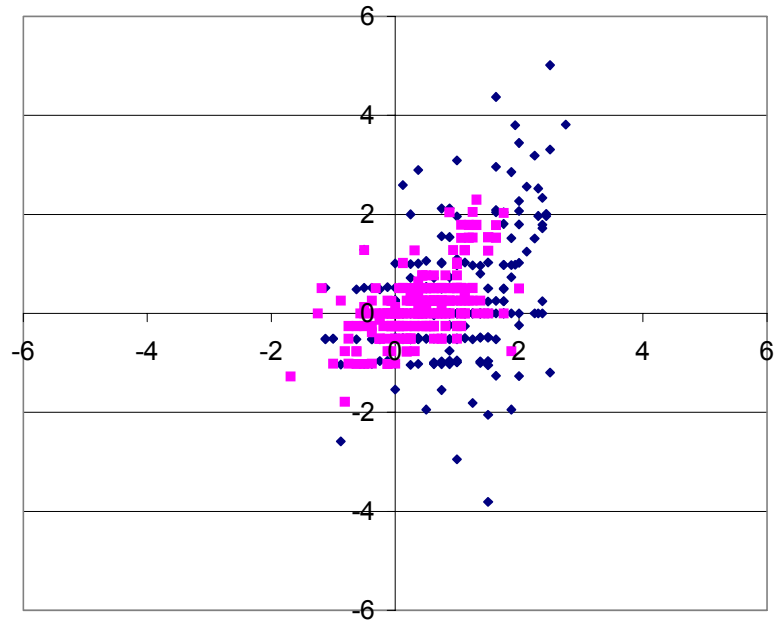
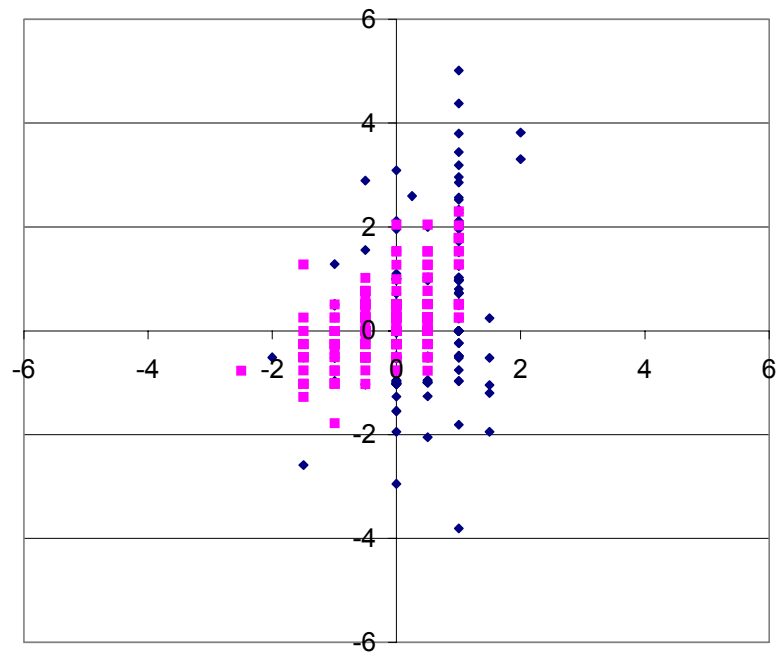


Figure 7b. Covered interest parity: bank rates



*b) Covered interest parity, 2: a naïve test*

To go beyond the previous exercise, a popular test of CIP (MacDonald [1986]) is to run:

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

where the null that (2) is true is accepted if one cannot reject  $\alpha=0$  and  $\beta=1$ . The results of this test are reported in table 3. Once again the results indicate that a transformation occurred around 1896, as evidenced by the improved “fit” of the model after 1896. At the same time, these tests lead to *reject* the assumption of covered interest parity for all sub periods. On the surface, the integration of money and foreign exchange markets does not seem to have been perfect.

Table 3. Integration of money and FX markets: Tests of  $(f_{i-s_t})_{1200} = \alpha + \beta(i - i^*) + \varepsilon_t$ 

Period	$\alpha$	$\beta$	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	F(2,414)=102,35
1876 :11-1896 :3	-0,26 (-2,38)	0,55 (6,25)	0,14	1,68	F(2, 193)=54,08
1896 :4-1914-8	-0,08 (-2,03)	0,58 (9,76)	0,30	1,36	F(2,219)=51,14
BANK RATES DIFFERENTIALS					
1876 :11-1896 :3	0,15 (3,61)	0,50 (8,25)	0,12	1,48	F(2,414)=5,84
1876 :11-1896 :3	0,04 (0,56)	0,60 (5,21)	0,10	1,55	F(2,193)=6,47
1896 :4-1914-8	0,24 (6,25)	0,50 (8,88)	0,26	1,28	F(2,219)=78,60

Source: authors' computations: see text. T-stats in parentheses. Results with Vienna's minimum market rate.

*c) Covered interest parity: within the neutral band*

i) A test from first principles

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 [1986]).

In our case, however, a direct measure can be obtained. Consider, as do Federn [1910] and Einzig [1937], a banker who seeks to take advantage of interest rate discrepancies between Berlin and Vienna. He has access to both money markets where he can lend or borrow at the prevailing open market rate.<sup>24</sup> If (2) does not hold, for instance, when the Berlin rate is too high, a covered arbitrage is feasible (a symmetrical reasoning holds if the rate in Vienna is too high). This involves borrowing florins for one month in Vienna, selling the proceeds against marks on the spot market, then lending in Berlin for one month while covering the operation through a forward contract.<sup>25</sup> For this operation, it is the market rate, not the bank rate, which is relevant, motivating our subsequent focus.<sup>26</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 (he is a seller in one transaction and a purchaser in the other one). This amounted, for both spot and forward

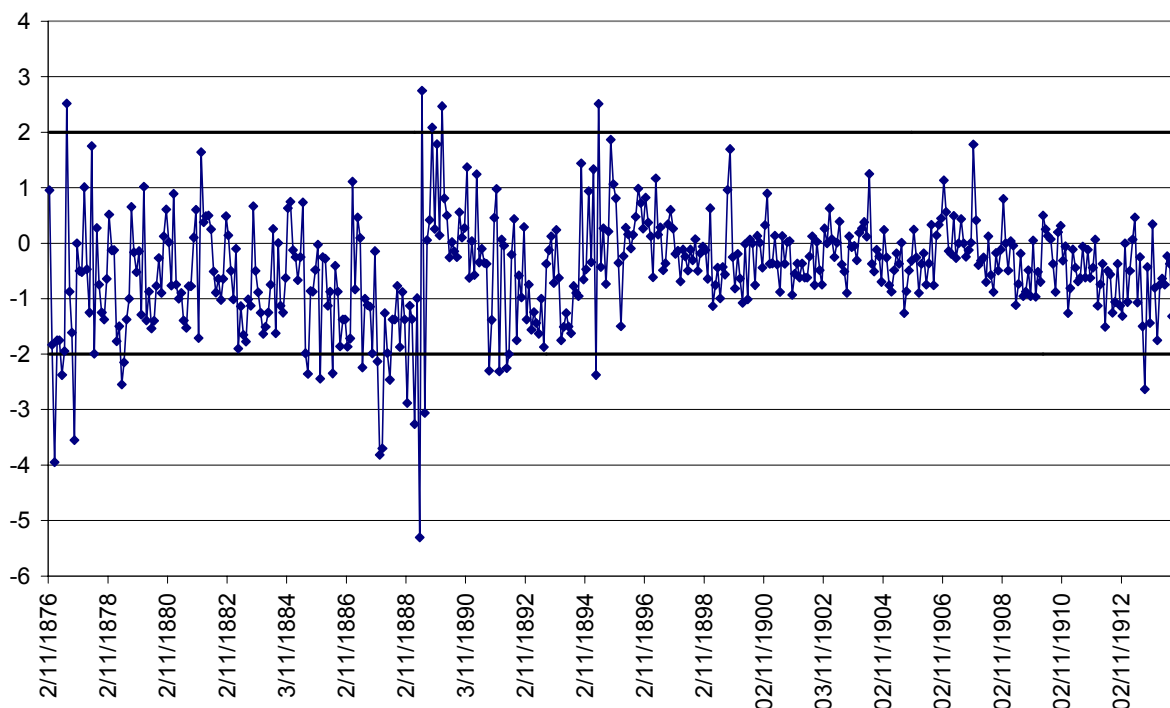
transactions to about 0.1 florin while the exchange rate fluctuated around 60 fl., or an interest loss of about 2% per annum (200 basis points). Formally: arbitrage should produce:

$$-2\% \leq (f_t - s_t) \cdot 1200 - (i_t - i_t^*) \leq +2\% \quad (4)$$

Consistent with this argument, figure 8 depicts the deviations from covered interest parity (implicit rate of depreciation minus interest rate differential) and compares them to the “neutral band”. As seen, violations were fairly frequent before 1896. They virtually disappeared, but for one exception, thereafter. Moreover, the deviations were found after that date in a much narrower range than the neutral band suggesting that there were some other forces, on top of covered arbitrage, that prevented discrepancies for growing “too large”, a point to which we return below. 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 2.b 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 2.b. But this should not be interpreted so as to imply that autonomy disappeared entirely. Only it was concealed behind a veil of arbitrage expenses.

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



ii) Was there a dynamic causality structure?

The finding that deviations from CIP were on average small and non-persistent (Figure 8) 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 market expectations 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 (as was the case in 1907). Instead, they could let the spot exchange rate fall and/or the forward rate rise in order to increase the forward premium.

Thus, one would expect interest differentials to be the exogenous variable, while the expected exchange-rate changes are endogenous and react with a lag to changes in the interest differential. This is the hypothesis we proceed to test using a two dimensional VAR model that involves both terms of the covered interest parity equation. Formally we have:



$$\begin{cases} \varphi_t &= \alpha_0 + \alpha_{11}\varphi_{t-1} + \alpha_{12}\varphi_{t-2} + \dots + \alpha_{21}(i_{t-1} - i_{t-1}^*) + \alpha_{22}(i_{t-2} - i_{t-2}^*) + \dots + v_{1t} \\ i_t - i_t^* &= \beta_0 + \beta_{11}\varphi_{t-1} + \beta_{12}\varphi_{t-2} + \dots + \beta_{21}(i_{t-1} - i_{t-1}^*) + \beta_{22}(i_{t-2} - i_{t-2}^*) + \dots + v_{2t} \end{cases} \quad (5)$$

where  $\varphi_t = (f_t - s_t) \cdot 1200$  is the expected rate of exchange-rate change, and  $v_i$  ( $i=1,2$ ) are random shocks. 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). Estimates are revealing. First, interest differentials are fairly persistent (much more than expected rates of depreciation). Using market interest rates we see that none of the coefficients of the lagged values of the other variable (bold-faced) is significant for the period of the float prior to 1896 (Table 4a, columns 1 and 2). This is also the case using bank rates (Table 4.b, columns 1 and 2). These are important results, because they imply that the forward premium was not a good predictor of the interest rate differential and the interest rate differential between Vienna and Berlin, in turn, was not a good predictor of the forward premium. The Granger causality values reflect this by being small and insignificant.<sup>27</sup>

Second, we observe a clear change in the causality structure when we compare the period before 1896 to the period after. After 1896, an obvious one-way causality goes from the interest rate differential to the expected rate of depreciation, regardless of the interest differential we focus on. The Granger causality coefficient is large and significant only in column 3.<sup>28</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), are virtually identical before and after 1896, except that during the float, bank rates tended to be 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. The stabilization of the currency within a band had thus succeeded in not jeopardizing the precious leeway that flexible exchange rates provided in the past.

Clearly, despite having stabilized their currency within a narrow band, authorities could use the exchange rate as a substitute to interest rate hikes. In other words, the relation between exchange rate and interest rate differentials that is at the heart of target zones was only concealed behind transaction costs. Underneath that crust, forward premia and interest differentials interacted in a way

that enabled Habsburg monetary authorities to run the florin target zones along the lines of a textbook that was not yet written.

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

Dep. Var.	1876-1896		1896-1914	
	(1) $\phi$	(2) $i-i^*$	(3) $\phi$	(4) $i-i^*$
$\phi$ (-1)	0,058 (0,87)	<b>0,05</b> <b>(1,75)</b>	0.30 (4.21)	<b>-0.13</b> $10^{-2}$ <b>(-0.02)</b>
$\phi$ (-2)	0,23 (3,62)	<b>-0,017</b> <b>(-0,54)</b>	0.06 (0.85)	<b>0.03</b> <b>(0.46)</b>
$\phi$ (-3)	0,16 (1,65)	<b>0,034</b> <b>(1,03)</b>	0.19 (2.58)	<b>-0.06</b> <b>(-0.85)</b>
$\phi$ (-4)	0,19 (3,00)	<b>0,031</b> <b>(0,94)</b>	-0.08 (-1.14)	<b>-0.02</b> <b>(-0.30)</b>
$i-i^*$ (-1)	<b>0,17</b> <b>(1,33)</b>	0,57 (8,56)	<b>0.41</b> <b>(5.30)</b>	0.57 (7.70)
$i-i^*$ (-2)	<b>-0,01</b> <b>(0,06)</b>	0,13 (1,77)	<b>-0.20</b> <b>(-2.26)</b>	-0.06 (-0.78)
$i-i^*$ (-3)	<b>0,11</b> <b>(0,07)</b>	0,17 (2,30)	<b>0.09</b> <b>(1.04)</b>	0.23 (2.76)
$i-i^*$ (-4)	<b>0,06</b> <b>(0,50)</b>	-0,13 (-1,9)	<b>-0.09</b> <b>(-1.12)</b>	-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.	<b>1.36</b>	<b>1,91</b>	<b>7.37 (*)</b>	<b>0.27</b>
Schwartz BIC		-0.89		-2.61

Periods are 1896:11 to 1896:3 and 1896:3 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.

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

	1876-1896		1896-1914	
	(1)	(2)	(3)	(4)
	$\phi$	$i-i^*$	$\phi$	$i-i^*$
$\phi$ (-1)	0,07 (1,16)	<b>0,02</b> <b>(0,78)</b>	0.34 (4.82)	<b>0.03</b> <b>(0.60)</b>
$\phi$ (-2)	0,25 (3,94)	<b>0,02</b> <b>(0,83)</b>	0.02 (0.27)	<b>-0.05</b> <b>(-0.88)</b>
$\phi$ (-3)	0,12 (1,96)	<b>0,03</b> <b>(1,06)</b>	0.24 (3.34)	<b>0.85 10<sup>-2</sup></b> <b>(0.14)</b>
$\phi$ (-4)	0,21 (3,31)	<b>-0,006</b> <b>(-0,25)</b>	-0.07 (-0.96)	<b>0.40 10<sup>-2</sup></b> <b>(0.07)</b>
$i-i^*$ (-1)	<b>0,17</b> <b>(1,08)</b>	0,76 (11,12)	<b>0.38</b> <b>(4.23)</b>	0.78 (10.81)
$i-i^*$ (-2)	<b>0,04</b> <b>(0,19)</b>	-0,02 (-0,31)	<b>-0.21</b> <b>(-1.87)</b>	0.04 (0.52)
$i-i^*$ (-3)	<b>-0,19</b> <b>(0,93)</b>	0,06 (0,74)	<b>0.10</b> <b>(0.93)</b>	-0.01 (-0.16)
$i-i^*$ (-4)	<b>0,12</b> <b>(0,71)</b>	-0,08 (-1,29)	<b>-0.18</b> <b>(-1.97)</b>	-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

Periods are 1896:11 to 1896:3 and 1896:3 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.

## Conclusion

The modern theory of target zones, as re-discovered by Svensson, Krugman, and even Keynes, was actually first developed before WW I by forgotten Habsburg policy makers such as Governor Bilinski, as recognized and stressed by contemporary financiers such as Walther Federn. 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) to economics (Menger, Böhm-Bawerk). In many respects, the twentieth century was born in this unlikely place in Central Europe. 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 monetary management practices of the Austro-Hungarian bank. This is a case in which practice preceded theory.

This Austro-Hungarian success story, in stark contrast to the utter failure of modern experiments, does hold a lesson for today: while letting the Austro-Hungarian currency fluctuate within a fairly 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 recent 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 more important features that played a decisive role in the outcome. The first was foreign exchange market efficiency. We found that a central aspect of the Austro-Hungarian record was the 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 exchange rate regime does not only influence the behavior of policy makers, but also the very quality of expectations. Not only policies, but market expectations as well, change when one moves to a target zone. The existence of this microeconomic channel, in turn, implies that the advantages traditionally associated with floating exchange rates such as the ability to have an autonomous monetary policy are perhaps best secured in a currency band: 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>29</sup>

Second, our study of covered interest parity has demonstrated that the traditional 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 not appropriate. Covered interest arbitrage involves 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. Using Granger causality tests, we demonstrated that the transition to the florin band after 1896 introduced a dynamic, one way, link 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.

Finally, it should be noted that the florin target zone did not have pre-specified bounds, but only informal ones which the market could only infer. While the best economic minds of the time, such as von Mises, failed to fully comprehend the relevance of this system and advocated, to no avail, stricter «rules» to foster credibility (Mises [1909]), other authors such as Federn understood the advantage of not tying the fate of the currency to pre-specified intervention levels: formal convertibility would have committed monetary authorities to throw their entire reserves in an exchange rate battle at the gold point, should a confidence crises arise, hereby creating scope for one sided bets. Letting the exchange rate depreciate beyond the gold points and eventually using foreign exchange reserves to prevent further departure from parity enabled authorities to circumvent this problem. Clearly, the implication is that a successful target zone relies on the defense of the long run target - not on formal bands. It would take the 1992 and 1993 ERM crises for modern policy makers to relearn this simple lesson, that it is the parity, not the boundary, that matters. 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 economist to digest the heritage of deceased policymakers.

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***Data appendix.***

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 ( $(\{Geld(t)+Waare(t)\}/2, 1876 :11-1914 :7)$ ) 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.

## 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> For the political economy of this question, see Michel (1976) and Flandreau (1999).

<sup>3</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.

<sup>4</sup> On the connections between Federn and the bank’s establishment, see Einzig [1937].

<sup>5</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>6</sup> For contemporary evidence that the bank changed the discount rate much less frequently than Berlin and London, see von Mises (1909b, 1010).

<sup>7</sup> Determining the extent to which Keynes was directly inspired by the Austro-Hungarian precedent

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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 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. 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>8</sup> 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 high 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

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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.

<sup>9</sup> However, 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 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).

<sup>10</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.

<sup>11</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>12</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.

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<sup>13</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>14</sup> The new parity was leaked to the market between April 18 and 23<sup>rd</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>15</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 +/-0,4% band in April, and this motivates our choice.

<sup>16</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>17</sup> . This is also in contrast to findings reported in the recent literature for more recent experiments (MacDonald 1988, de Grauwe 1989).

<sup>18</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>19</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>20</sup> Note: both  $f$  and  $s$  are in logarithms. We multiply by 12 to obtain annualized rates and by 100 to obtain percentage.

<sup>21</sup> The inter-bank interest rate, known in *The Economist* as the “open market” rate, was the rate for loans of up to three months. In the normal course of its business a bank would typically hold a portfolio of bills of various qualities. On the one hand the bank would hold “prime” bills that would have been endorsed by several top institutions and would thus offer very high security, since every signature amounted to a legal pledge to pay the bill, should the previous endorser default on it. On the other hand there would be “investment” bills that the banker would have obtained by granting credit to a customer. These bills would be typically riskier and would carry higher interest rates. Should the bank need cash, it could typically get it through outright sales – at the market rate - of prime bills to other bankers. Alternatively, the bank could operate through repurchase agreements, getting credit at the market rate against a temporary transfer of a “mixed” portfolio of bills, with the lender taking a cut to protect himself against possible losses resulting from default (see Haupt [1894]). The open market rate was thus the rate at which one could lend money at a risk that was close to zero, as well as the cheapest way to get short term credit. It represents, at a given date, the best measure of the situation of the money market in a given center and will consistently receive close attention. We collected Austro-Hungarian rates from the Vienna stock exchange returns. German ones were taken from *The Economist* (see appendix).

<sup>22</sup> The official Bank rates also applied for less than three month credit. These were the rates at which central banks rediscounted bills. Central banks typically limited the scope of their operations to bills that had at least two or three signatures, thus shutting out the riskiest assets. On the other hand the rate they applied was unattractive for the very finest bills, which could be sold at better terms on the open market. Moreover, once in the portfolio of the Bank, the bills were kept until maturity with the

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Bank taking care of cashing them. (Because cashing bills was costly and cumbersome, some banknotes turned the bank a few days before maturity, in fact as soon as the loss incurred by rediscounting the bill outweighed the costs of cashing it.) In other words, unlike the open market rate, the Bank rate was only a lending rate: nobody could lend at zero risk at the bank rate. This is why the Bank rate is a poorer measure of the market situation than the market rate was. Of course the way the official rate was set had an indirect influence on market rates, since the Bank would provide last resort rediscounting facilities. And in view of the monetary authorities' primary concern with securing policy autonomy, the Bank rate remains a useful indicator which is worth examining. (Bank rates for both Austria-Hungary and Germany are available from the Vienna stock exchange returns (see data appendix).) Moreover a number of international deposits were made at conditions that were directly related to the bank rate (Flandreau and Gallice [2001]): thus the official rate influenced the profitability of foreign balances and could thus directly impact international flows of money. This is why we shall consider both measures in turn.

<sup>23</sup> Einzig's 'graphical' covered interest parity tests for the interwar years also consider the rate on reports. These rates were quoted at the beginning of the month for money to be borrowed until the next « liquidation » (see above). They thus exactly matched the time period covered by a forward exchange rate contract subscribed at the beginning of the month and from that point of view should be the ideal rates to work with. At the same time, these rates, in a given market and date, were specific to each security involved. In practice, this complex market microstructure was sustained by transaction costs that prevented full arbitrage between those security specific rates (see Flandreau et Sicsic [2000] for a discussion of the French case). The only way to go to derive a "market" rate for reports (in the absence of an existing portfolio index as the one uncovered for France by Flandreau



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and Sicsic) would be to work out the “average” rate for a portfolio of securities. But it is not clear how this portfolio should be defined and we decided not to leave reports out. (see Einzig [1937]).

<sup>24</sup> « The practice of interest arbitrage had been highly developed in Vienna for decades before the war. To some extent foreign centres regularly utilized the facilities of the Vienna money market for short term investments. The Vienna banks themselves were past masters in such transactions. They employed their liquid resources abroad whenever this was profitable, and they were usually able to borrow abroad and employ the funds in Vienna whenever such operations showed a margin of profit » (Einzig, p. 332)

<sup>25</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). While von Mises did not consider exchange-rate risk, obviously practical men, such as Federn, did.

<sup>26</sup> On the borrowing end of the arbitrage, bankers seek to get the lowest rate, and this is the market rate. And on the lending end, it is obvious that no banker has access to zero risk lending at the central bank official rate.

<sup>27</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>28</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>29</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

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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.