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ABSTRACT

Target Zones in Theory and History: Credibility, Efficiency, and Policy Autonomy*

A natural experiment with an exchange-rate band in Austria-Hungary in the early 20th century provides a rare opportunity to discuss critical aspects of the theory of target zones. Providing a new derivation of the target zone model as a set of nested hypotheses, the inference is drawn that policy credibility and market efficiency were paramount in the success of the Austro-Hungarian experience.

JEL Classification: F31 and N32
Keywords: Austria-Hungary, covered interest parity, credibility, market efficiency hypothesis, monetary model, monetary policy and target zone

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Introduction.

An early experiment with an exchange-rate band was implemented in the Austro-Hungarian monarchy between 1896 and 1914. This remarkable episode is relevant for modern research, because it was explicitly designed along principles spelled out more recently in modern "target zone theory" (TZT) (Krugman, 1991). The Austro-Hungarian exchange-rate band operated smoothly for almost two decades, in stark contrast to many recent unsuccessful experiences with such target bands, which tended to collapse in infamous speculative attacks. The bank received lot of praise for its innovative policy. For example, the Governor of the Austro-Hungarian central bank, Leon Bilinski, found the bank's policy "original", "excellent", an "innovation" that had enhanced its reputation greatly (Federn, 1911, p. 1388). Contemporary observers rationalized the system in strikingly modern terms: they emphasized that exchange rate depreciation within the band triggered stabilizing expectations that minimized the need for aggressive interest rate increases (Federn, 1910, p. 662; 1911, 1391; 1912). This notion is reminiscent of Svensson's (1992, 1994) emphasis that currency bands work by reconciling policy autonomy with exchange rate stability.

Thus, the Austro-Hungarian target zone operated in practice just like target zones are supposed to operate in theory. This fact makes it a quite useful natural experiment that has the potential to tell us a lot about a prominent theory. To this end, the paper is organized as follows. Section I provides the historical background. Section II gives an original derivation of the basic target zone model as a set of nested hypotheses. Empirical tests using New data from primary sources are performed in Section III. They explain the key reasons for the success of the Austro-Hungarian experiment: foreign exchange market efficiency and policy credibility. Section IV, finally, shows that covered interest parity is a much less essential ingredient to the TZT than conventionally thought. The conclusion emphasizes the importance of the historical lesson for both theory and policy.

Section I. A success story

Svensson credits Keynes for a pioneering statement of modern target zone theory. Keynes argued that the degree of short-term policy autonomy increased with the distance within the "gold points" (as the gold standard exchange rate band was known): "The degree of separation between the gold points is a vital factor in the problem of managing a country's currency […] [Widening the band] would permit temporarily the maintenance of materially different short money rates in the two centers" (Keynes, 1930). As Einzig (1937, p. 332-3) recognized, Keynes' insight had its roots in the pre-war policy of the Austro-Hungarian Central Bank, which "closely resembles Mr. Keynes's proposal for the widening of the margin between gold points".[1]

These policies emerged in 1896 to reconcile conflicting goals. Monetary authorities had wanted to achieve exchange rate stabilization in terms of a new gold parity, but they were also concerned with retaining part of the protection from external shocks that was thought to have existed behind the "Chinese wall" of a flexible exchange rate (Lotz, 1889). In particular, they wanted to smooth out variations of the interest rate. They thought that brutal interest hikes, imposed by monetary policy abroad, would have adverse real effects of the economy (Knapp, 1905, p. 250; von Mises, 1909b). An additional concern arose from politics. Austria-Hungary was in effect a monetary union and discount rate changes were a potential source of political conflict between the Austrian and Hungarian parts of the monarchy (Flandreau 2005). Therefore, their occurrence was to be minimized.

[1] To what extent was Keynes directly inspired by the Austro-Hungarian precedent? No explicit reference to the Austro-Hungarian case has been found in Keynes, who discusses instead the French experiment with "gold devices". Yet, the Austrian discussions on this issue had reached the British public very early on, through von Mises's publication in the Economic Journal (1909a), an article with which Keynes would no doubt have been familiar given his position at the Journal. 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 (Hodgson, 2001).

The solution found was to stabilize the currency against the German mark within an informal band. The policy was implemented gradually. Until 1889, the Austro-Hungarian currency was essentially a free float (Yeager, 1969). From the Summer of 1889 until 1892, a debate developed about the relative merits of fixed vs. flexible exchange rates. In 1892, the supporters of stabilization won and a new gold parity was set close to the current exchange rate. Though the new parity was soon leaked to the market, the law adopting it was not formally ratified by both the Austrian and Hungarian parliaments until the following year (Flandreau and Komlos, 2002). Moreover, no practical steps were taken for effective stabilization. Exchange rate movements resumed despite occasional foreign exchange market interventions. The delay resulted from internal conflict between Austria and Hungary, unable to agree on the design of the Bank's charter in the event of currency stabilization. The reason was fostering the credibility of the Bank meant increasing monetary dominance at the expenses of the respective governments of Austria and Hungary.

In March 1896, however, the adoption of an informal target zone policy, apparently decided unilaterally by monetary authorities, ushered in an era of exchange rate stability. In 1899 the Bank's Charter was finally agreed upon. Coinage of a new currency began in 1900. In August 1901 the Bank announced that it would normally trade gold coins against its banknotes. By the end of the following year, the withdrawal of government banknotes from circulation – which had begun after 1894 – was completed. At the same date, the so-called "Ischl agreement" decided that the central bank would become the sole repository of the foreign exchange balances that the two governments accumulated to service their external debts (governments dealt previously with international banks). As a result, the central bank became a key player in the foreign exchange market (Kövér and Pogány 2002). According to contemporary analysts, this set of decisions opened the "heyday" of an Austro-Hungarian currency band (von Mises, 1909a, p. 203). It would last about 13 years, until WW I.

The size of the band was understood by market participants through informal contacts between bank officials and the financial community to be of about [–0.4%,+0.4%] around parity, corresponding to the cost of shipping gold between Vienna and Berlin or London (von Mises, 1909a; Einzig, 1937). It appears that the bank had an intuitive understanding of the dangers of one-sided bets and avoided specifying explicit bands that would have committed authorities to throw their entire reserves in an exchange rate battle, should a confidence crises arise (Federn 1909). The informal band was defended through discretionary foreign exchange intervention when the exchange rate approached its informal boundaries. The minutes of the board meetings of the Austro-Hungarian Bank do suggest that there was no formal red line: authorities could occasionally retreat before marching again: the effective band is probably best described as a [-0.5;0.5] interval.[2]

Figure 1 about here.

According to observers, this arrangement enabled monetary authorities to adjust monetary policy to domestic conditions. When, for instance, interest rates increased in Berlin, monetary authorities in Vienna were able to let the exchange rate go as a substitute for competitive interest rate hikes. The way contemporaries understood this to work was strikingly modern: *exchange rate depreciation, they argued, triggers stabilizing expectations of eventual exchange rate recovery, because agents understand that the exchange rate will remain within the band*. For instance, Federn (1909) argued that the exchange rate depreciation that would follow the decision to keep interest rates low should be “small, because the excess demand for foreign exchange [in Vienna] disappears by itself, insofar as the small expected increase in benefits to be gained through interest rate arbitrage is compensated

[2] Specifying it this way only leaves out six observations for the period 1901-1914 (monthly data). There was a debate on the exact form of foreign exchange interventions. Von Mises insisted that all interventions were on the spot market. Federn, followed by Einzig, claimed that these were complemented by forward interventions. However, our perusal of board minutes during the critical episode of 1907 did not find references to forward interventions (Austrian National Bank Archive, “Protokollen”, October 24, 1907; November 9, 1907; November 28, 1907).

by the risks of losses due to [the threat of a future recovery] in the exchange rate."[3] Similarly Einzig (1937, p. 332-3) explained that "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."

Table 1 about here

Evidence of the success of the Bank's policy includes the fact that official discount rate changes in Vienna were only marginally less frequent before the currency was stabilized than when it was pegged within a narrow band (Table 1). Contemporaries thus concluded that the exchange rate stability after 1896 had *not* been secured at the expense of monetary policy autonomy (von Mises, 1909b p. 1010). Another popular piece of evidence was the bank's performance during the 1907 international financial crisis (Einzig 1937).

The 1907 crisis originated in the US and soon spread to major European financial centers. In Berlin, the *Reichsbank* raised its rate from 5.5 to 6.5 percent on November 1 and then again from 6.5 to 7.5 percent on November 11. Yet the currency band shielded Vienna, contemporaries argued, and indeed, the examination of the evidence confirms this view (Figure 2). Figure 2 is based on daily data from primary sources, and shows the spot and forward rates against the mark along with official bank rates in Vienna and Berlin. It is evident that the Austro-Hungarian monetary authorities were able to tolerate a widening spread against German rates: it reached 250 basis points in the middle of November before stabilizing at 150 basis points. Contemporary analysts rationalized this by pointing to the fascinating behavior of the spot and forward rates. Until early November, when the

[3] 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 (1937, p. 335) and Federn, (1910b, p. 666). In the 1910 article Federn referred explicitly to the need to cover exchange-rate risk by selling forward marks.

Austro-Hungarian currency was "strong" (i.e. below parity) forward marks traded at a premium (above spot rate): market participants expected an eventual depreciation of the florin. When crisis hit, authorities let the exchange go: as a result the exchange rate became "weak" (above parity) but forward marks traded at a discount (below spot rate): market participants now expected an eventual appreciation of the currency. Observers surmised that by letting the exchange rate go above parity, monetary authorities had induced speculators to play the florin up. In summary, there was stabilizing speculation inside the currency band (Federn, 1909; Einzig, 1937). The most impressive aspect of the 1907 crisis is its "textbook" TZT character (Figure 2).

Figure 2 about here

Section II. Back to basics: Target Zone Theory Revisited

Target Zone Theory (TZT) discusses the effect of monetary arrangements on the determination of the exchange rate in a dynamic forward-looking framework. Although initially developed in the context of Cagan's monetary model,[4] the framework is consistent with a variety of theories of exchange rate determination. The only critical assumption (denoted H_1) is that agents are rational so that the expected exchange rate is the mathematical expectation of future exchange rate changes (for simplicity, risk aversion in not considered). Then:

$$e = \square \left(k, E\left[de\right]/dt\right) \qquad (1)$$

In continuous time with e the exchange rate, E[de]/dt the expectation of instantaneous changes in the exchange rate, and k a function of the "fundamentals" (the money supply, velocity, tastes, productivity, relative prices, etc.). A linear version of equation (1) is:

$$e = k + \square E\left[de\right]/dt \qquad (2)$$

[4] Assumptions required to achieve this are PPP, UIP and a Cagan money demand function.

Consider now that monetary authorities set a symmetrical exchange rate band – or "target" – defined as [-c; +c]. They let the exchange rate float "freely" when it is within the band but intervene when the exchange rate hits the boundaries. "Intervention" means adjusting k: for instance, adjusting the money supply.[5] Therefore, fundamentals are prevented from leaving a pre-assigned, symmetrical band (given the assumed symmetry of the problem): $k \in [-h; +h]$, with h being a parameter to be determined.

The second assumption of TZT (H_2) is that the policy described above is credible. Monetary authorities can persuade market participants that they are committed to the currency band. If markets are efficient, this hypothesis implies that the forward exchange rate (a predictor of the future exchange rate) is always found within the fluctuation band [-c; +c]. H_1 and H_2 also imply that mean reversion is built into the process for the exchange rate. Rational agents expect the exchange rate to appreciate when the exchange rate is depreciated, and to depreciate when it is appreciated. The result is a downward sloping relation between the location of the exchange rate within the band and the expected rate of currency depreciation (i.e. the forward premium $\square = E\left[de\right]/dt$).

An explicit illustration of this can be derived in the simplest case when fundamentals follow a continuous time random walk. The random walk is augmented by the marginal interventions on fundamentals that prevent the exchange rate from leaving the band:

$$dk = \sigma dz + dL - dU \qquad (3)$$

Where σdz is the so-called "diffusion" in a Brownian motion process, and dL (resp. dU) is the infinitesimal adjustment of fundamentals that authorities implement when k reaches its lower (resp.

[5] This is the conventional interpretation of the way monetary authorities modify the money supply to prevent the exchange rate from leaving the band (i.e. non-sterilized foreign exchange market intervention).

upper) bound. Combining the previous equations, and setting $\lambda = \sqrt{2/\alpha\sigma^2}$ gives the general solution, where A is a parameter that is solved using "boundary conditions":[6]

$$e = k + A \cdot \left(e^{k \cdot \lambda} - e^{-k \cdot \lambda}\right) \tag{4}$$

$$\delta = \frac{A}{\alpha} \cdot \left(e^{k \cdot \lambda} - e^{-k \cdot \lambda}\right) \tag{5}$$

Using equations 4 and 5, it is possible, for a given k and set of parameters, to derive numerically the implicit (negative) relationship between e and δ.

Figure 3 about here

However, this testable implication of TZT is not the one usually considered in the literature. Previous researchers have focused on an alternative relation requiring a third hypothesis (H_3): Covered Interest Parity (CIP) requires that interest rate differentials are identical to the forward premium (otherwise an arbitrage is feasible). If i is the interest rate in Vienna, and i* the rate in Berlin:

$$i - i^* = E\left[de\right]/dt = \delta \tag{6}$$

Combined with H_1 and H_2, H_3 implies that one should expect a negative correlation between the exchange rate and the interest rate differential. Equation (6) is just the same relation as depicted in Figure 3, where the expected rate of depreciation has been replaced by the interest differential. This very prediction has been tested and rejected in numerous contemporary studies (Svensson 1991, Flood, Mathieson and Rose 1991, Lindberg and Söderlind, 1991), and researchers now doubt the relevance of the simplest version of TZT.

The rationale for this more demanding test is questionable. Initial presentations of TZT placed much emphasis on the monetary model of exchange rate determination and this motivated CIP. Yet,

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[6] The derivative of the exchange rate when fundamentals reach their upper bound h is zero, while the exchange rate is c.

the validity of this model is disputed (Meese and Rogoff 1984). Moreover, this section has shown that assuming CIP is not essential for the key TZT result.

Section III. Nested Hypotheses: Tests and Results

The tests in this section rely on a new database collected from primary sources. The database is unique because evidence on 19th century forward markets is sparse.[7]

a) *Hypothesis H_1: strong form efficiency*

Fama (1984) argues that if foreign exchange markets are (strongly) efficient, the forward premium should be an unbiased predictor of actual exchange rate changes: calling ε_t a random shock, e_t the log spot rate at month t, f_t the log forward rate quoted at month t for delivery at t+1:

$$e_{t+1} - e_t = \alpha + \beta\left(f_t - e_t\right) + \varepsilon_{t+1} \qquad (6)$$

Efficiency implies $\beta = 1$ and $\alpha = 0$ (if investors are risk neutral). An abundant literature has tested this relation on contemporary data, but 19th-century forward markets have remained unexplored.[8] The entire sample spans 1876:11 to 1914:7. In line with the historical discussion, the period under study is divided into three sub periods: floating exchange rates before March 1896, the "transition" between April 1896 and July 1901, and the "currency band" after August 1901. To be comprehensive, a number of sub-periods in the first epoch, motivated by policy/institutional changes emphasized in Section I, are also considered.

Table 2 about here

The results of regressions 1 and 2, corresponding to the period before 1901, resemble those obtained in literally hundreds of other studies of market efficiency (MacDonald 1988): low t-

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[7] 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. The data as well as information on early forward markets can be found online under: Early forward exchange markets: Vienna 1876-1914 at http://www.eh.net/databases/dsonline.php.

statistics, occasionally negative □'s, and negligible R^2s (Table 2). Strictly speaking, market efficiency is not always rejected for the period before 1901 but this comes from the low explanatory power of the regressions (lines 1, 1a, 1b). In other cases, efficiency is clearly rejected (lines 1c and 2). Before 1901 foreign exchange markets were not efficient.

During the interval 1901 through 1914 however, results are markedly different. In fact, they become a textbook illustration of a successful efficient markets test. The slope coefficient estimate is .99, its standard error is small, and the constant is zero. Residuals are also well behaved, and the predictive power of the forward premium is more important than in the other regressions (adjusted R^2=0.14). The F-test leads to accept the MEH at 5%. In sum, during the heyday of the Austro-Hungarian currency band, exchange market efficiency did hold. This conclusion is striking in itself, because there are few such results in the contemporary literature (De Grauwe, 1996).

a) Hypothesis H_2: Credibility

The simplest test of credibility in a fluctuation band is known as Svensson's "100% credibility test". As explained in Section II, if markets are strongly efficient, the forward rate is a predictor of the future exchange rate. Consistently, it must lie within the currency band – or else, this would denote that the band is not credible. The result of the test using the [-.5%,+5%] interval is reported in Figure 4. It is evident that "violations" were rare, practically nonexistent after 1901. In other words, future trades factored in the fact that monetary authorities would take action to prevent continued departure from the currency band. The conclusion is that after 1901, the currency band was fully credible. (For further tests see Flandreau and Komlos 2002 and Jobst 2001).

Figure 4 about here

b) H_1 and H_2: the exchange rate and the expected rate of depreciation

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[8] The only related study is Koppl and Yeager (1996) who focus on inefficiencies in the ruble/mark forward market in the

With efficiency and credibility holding between 1901 and 1914, one would expect that there should be a negative relationship between the exchange rate and the (annualized) expected rate of depreciation ($\square = \square$ x 12 months 100 per cent). The test is depicted in Figure 5. Observations from 1896-1901 are represented by a circle, and observations from 1901-1914 with a dark dot. A fitted (linear) slope is included for the latter period. The result is striking: after 1901, there is a significant, negative relationship. This finding is the only instance of such a clear pattern reported in the target zone literature.

Figure 5 about here

c) Bonus: fitting Krugman's model.

The non-linear relation in Figure 3 is now adjusted to the data in Figure 5. Two implicit functions are defined: $e^{\square 1}_{\square,\square^2}$ and $\square^{\square 1}_{\square,\square^2}$ parameterized with $\square$and $\square^2$, the model's only exogenous parameters (this can be done because the functions are strictly monotonous):

$$\begin{cases} \square_i = \square_{\square,\square^2}(k_i) \; \square \; k_i = \square^{\square 1}_{\square,\square^2}(\square_i) \\ e_i = e_{\square,\square^2}(k_i) \; \square \; k_i = e^{\square 1}_{\square,\square^2}(e_i) \end{cases} \tag{7}$$

Solving (7) gives the theoretical relation between the (monthly) forward premium and the exchange rate. Therefore,

$$\begin{cases} \hat{\square}_i = \square_{\square,\square^2}(e^{\square 1}_{\square,\square^2}(e_i)) \\ \hat{e}_i = e_{\square,\square^2}(\square^{\square 1}_{\square,\square^2}(\square_i)) \end{cases} \tag{8}$$

where $\hat{\square}_i$ is the fitted forward premium and $\hat{e}$ the fitted exchange rate.

1890s. An illustration of weak form tests of market efficiency in historical context is Goldman (2000). Weak form tests consider whether in $e_t = \square . e_{t-1} + \square$, $\square = 1$.

Assuming that residuals are Gaussian, the problem is to find α and σ^2 that minimize the squared residuals. There are two alternative objective functions to minimize depending on which relation is considered, δ_i as a function of e_i or e_i as a function of δ_i:

$$\begin{cases} \sum_i (\delta_i - \hat{\delta}_i)^2 = \sum_i (\delta_i - \delta_{\alpha,\sigma^2}(e^{-1}_{\alpha,\sigma^2}(e_i)))^2 \\ \sum_i (e_i - \hat{e}_i)^2 = \sum_i (e_i - e_{\alpha,\sigma^2}(\delta^{-1}_{\alpha,\sigma^2}(\delta_i)))^2 \end{cases} \quad (9)$$

Exploiting properties of the problem brings about swift convergence. Fitting δ_i as a function of e_i gives α= 30,121 and σ^2=0.66 (pseudo-R^2 = 0.64). Fitting e_i as a function of δ_i gives α= 0.49 and σ^2= 0.02 (pseudo-R^2 = 0.78).[9] The difference between these alternative estimates is considerable despite an overall good fit in both cases (Figure 6). The estimates should therefore be thought of as boundaries for the "true" parameter values. This inference is also suggested by reference to "plausible" parameters that do lie between these bounds.[10]

Figure 6 about here.

Section IV. Does Target Zone Theory need Covered Interest Parity?

a) CIP and TZT

CIP has received much attention in TZT literature, although, as argued above, using this assumption is highly questionable. Evidence on its validity can be obtained by running straight tests of the basic prediction of the model when H_3 is assumed, i.e. projecting interest differentials on exchange rates. Results are report in the first part (section 1) of Table 3. Perhaps unsurprisingly,

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[9] A useful property of the problem is that optimal α is a function of λ ($=\sqrt{2/(\alpha\sigma^2)}$) so that the minimization problem boils down to minimization in terms of λ only. We thank Anton Granik for pointing this out to us and for solving it using MatLab. See details in technical appendix on Flandreau's website: available on www.financesinternationales.sciences-po.fr.

[10] The monthly volatility of fundamentals (σ^2) can be calibrated for the pre-target zone period. Given equation (2), the process the exchange rate must be identical to the process for fundamentals. This gives for instance 0.11 for the period preceding the adoption of the target zone (1892-1896). α may be inferred from estimates of interest rate semi-elasticity in money demand empirical studies. Knell and Stix (2004) report values around 0.1 for annual interest rates expressed

they are similar to those reported in related work (Bordo and MacDonald 2003; 2005, Hallwood, MacDonald and Marsh 1997; 2000). Specifically, the sign of the relation between interest differential and the exchange rate is negative but it is only marginally significant (non significant for market rates, and barely significant for bank rates). This is in striking contrast with the strong significance of the relation in Figure 5. This result shows the superiority of working with forward premia.

Table 3 about here

b) Testing for Covered Interest Parity

To highlight the importance of this result, we now test for CIP. To begin, we rely on a procedure suggested by MacDonald (1988). It consists in projecting the (annualized) forward premium on the interest differential, while allowing for autocorrelation of residuals. Formally:

$$\begin{cases} (f_t - e_t)\cdot 1200 = \alpha + \beta\cdot(i_t - i_t{*}) + \varepsilon_t \\ \varepsilon_t = \rho\cdot\varepsilon_{t-1} + \nu_t \end{cases} \qquad (6)$$

CIP implies α=0 and β=1. As shown in section 2 of Table 3, this assumption is rejected at conventional levels. However, regression analysis is not the best way to estimate CIP: CIP rests on an arbitrage argument but arbitrage entails costs. An alternative strategy is advocated by Frenkel and Levich (1975). It seeks to derive a zero profit condition from first principles. Consider a banker who performs CIP arbitrage between Berlin and Vienna (such operations were routine : Einzig 1937, p. 332). The banker can lend or borrow in either market at the prevailing rates. Suppose CIP does not hold: say, Berlin interest rates are too high. An arbitrage is to borrow florins for one month in Vienna, sell the proceeds spot, then lend in Berlin for one month while covering the operation through a forward contract. The operation implies one spot purchase and one forward sale: the

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in percentage (5 for 0.05 or 5%). Given that our interest rates are in decimals and are monthly, this means that β should hang around 120 (=0.1x100x12). Clearly 0.02<0.11<0.66 and 0.49<120<30,121.

banker ends up paying the bid-ask spread. Thus, the transaction costs amount to a 0.1 florin charge or, about 0.166% of the value of the transaction (since the exchange rate fluctuated around fl. 60), and is in line with modern standards. The result is an interest loss of about 2% per annum (0.166% times 12 months). Formally:

$$-2\% \leq (f_t - e_t)\cdot 1200 - \left(i_t - i_t^*\right) \leq +2\% \qquad (7)$$

The test is to compare the spread between interest differentials and the annualized expected rate of depreciation, to the "neutral band" [-2%,+2%]. Figure 7 shows few violations before 1896, and virtually none thereafter. After that date, deviations from CIP (zero line) are also found in a much narrower range and they were short lived. From this respect, CIP can be said to have prevailed after 1896.

Therefore, while CIP did hold, and the most basic version of the TZT applied after 1901, standard TZT tests that have been extensively applied in the literature (i.e. regression of interest differentials against exchange rates) may nurture undue reservations towards TZT theory. This result, simple as it is, is therefore of considerable importance.

Figure 7 about here.

c) Policy autonomy in target zones: an alternative approach

The intuition for the previous finding on the effect of arbitrage expenses on testable implications of TZT is the familiar principle of "Tobin Taxes": transaction costs on interest rate arbitrage have dramatic effects over a short horizon. It remains to be shown, though, that such "frictions" don't have any impact on the stability-autonomy trade-off.[11] To prove it, a final test is provided.

To begin, recall the earlier discussion of the 1907 episode. Monetary authorities in Vienna decided to resist interest rate hikes implemented in Germany. In the following days, the exchange rates (spot and forward) depreciated above parity. Since the forward rate depreciated less than the spot rate, the forward premium decreased and in effect became negative, just as the interest spread with Berlin rates set by Austro-Hungarian authorities: the point is that, because of transaction costs, "autonomous" changes in the interest rate spread caused *delayed* adjustments of the expected rate of depreciation, rather than *instantaneous* ones.

The natural test of policy autonomy is therefore to explore Granger causality between interest differentials and the expected rate of depreciation. Suppose that monetary authorities are able to set the interest rate in the way conventionally described in TZT. For instance, they wish to keep domestic rates lower than foreign ones. They will therefore set a negative interest differential, but since there are transaction costs, this will not immediately translate into a negative forward premium. However, after some lags adjustment will occur. *In other words, policy autonomy implies that (i-i*) should Granger cause ((f-e)1200) but not the other way round.*

The third part of Table 3 reports tests of this proposition derived from a 4-lags VAR system. Results are clear-cut. For the period of the heyday of the Austro-Hungarian currency band after 1901 there is strong evidence of a one-way causality going from interest rate differentials to the expected rate of depreciation. This finding is in contrast to the period prior to 1896, when Granger causality values are not significant in either direction. The conclusion therefore is that despite having stabilized their currency within a narrow band, authorities could deviate from the interest rate set abroad and induce the foreign exchange market adjust, following the lines of a textbook that was still to be written.

Conclusion

[11] Note that the literature on speculative attacks has emphasized that such frictions actually *increase* policy autonomy (Jeanne 1996).

Modern target zone theory has been reassessed in light of a historical precedent. Contrary to recent experiments, the Austro-Hungarian currency band between 1901 and 1914 is a straightforward illustration of the theory: market efficiency and a credible band are the two crucial ingredients for the basic TZT result to obtain. This conclusion is encapsulated in Figure 6, where the basic model is fitted, providing the first available evidence for its famous non-linearity. Another lesson is that the modern emphasis on the monetary model for exchange rate determination and covered interest parity has been probably misplaced. Because interest arbitrage typically entails costs, a proper measure of policy autonomy is the extent to which monetary authorities can set the interest rate and induce the foreign exchange market to adjust. This consideration is captured by a Granger causality test showing that interest differentials drove the expected rate of currency depreciation.

At a broader level, the Austro-Hungarian experience also conveys an important message. Some economists have worried that currency depreciation fuels speculation, calling for violent interest rate hikes. Another view, conventionally associated with the seminal study of Haberler (1949) – incidentally a student of von Mises – is that currency depreciation triggers stabilizing speculation: as the currency depreciates, domestic interest rates actually decline with respect to foreign ones. The above results have given us a sense of what is necessary for this policy to work. Announcing a target (rather than a formal band) and credibly committing to it could help a lot. But it should be equally clear that the success of the Austro-Hungarian target zones owes a lot to the efficiency of the foreign exchange markets of the time. At the end of this paper, one cannot help thinking that the real curse of modern financial markets is their inefficiency – and wondering whether "modern" theory is really modern.

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Table 1. Frequency of official discount rate changes

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

Source: Celli (1998).

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

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

Source: see text. t-statistics in parentheses. Regressions are based on bid prices except those marked with (a) which are based on the bid-ask average. A star (*) means that the null that α= 0 and β=1 is accepted at 5%. Breakdowns are July-August of 1889 (opening on debate on currency stabilization), and April-May 1892 (new parity leaked to general public).

Table 3. Covered Interest Parity: Explorations

Period	Market Rates	Bank Rates
Section 1. "Conventional" TZT test: $i_t \square i_t^* = \square + \square \cdot e_t + \square$. H_0= □≠0		
1901:8-1914:7	□=0.39 (7.98) Adj-R2=0.006 □=-0.29 (-1.41) REJECT	□=-0.23 (-4.68) Adj-R2=0.02 □=-0.43 (-2.08) ACCEPT
Section 2. "Conventional" CIP test: $\square(f_t \square s_t) \cdot 1200 = \square + \square \cdot (i_t \square i_t{*}) + \square_t$, $\square_t = \square \cdot \square_{t\square 1} + \square_t$ H_0 : □=1, □=0		
1901:8-1914:7	□=-0.11 (-2.07) □=0.44 6.48) □=0.19 (2.33) Adj-R2=0.27 F-Test=59.1 [0.0] REJECT	□=0.14 (2.59) □=0.35 (4.39) □=0.24 (3.05) Adj-R2=0.19 F-Test=48.76 [0.0] REJECT
Section 3. Causality tests: a) H_0: $(f_t \square e_t) \cdot 1200$ causes $(i_t \square i_t^*)$?		
1876:11-1896:3	1.19 [0.11] REJECT	1.02 [0.39] REJECT
1901:8-1914:7	0.27 [0.89] REJECT	0.22 [0.92] REJECT
b) H_0: $(i_t \square i_t^*)$ causes $(f_t \square e_t) \cdot 1200$ □		
1876:11-1896:3	1.36 [0.24] REJECT	0.66 [0.61] REJECT
1901:8-1914:7	5.14 [0.0006] ACCEPT	3.65 [0.007] ACCEPT

Source: see text. T-Stats in parentheses (), probabilities in brackets, significance assessed at 5%

Figure 1.

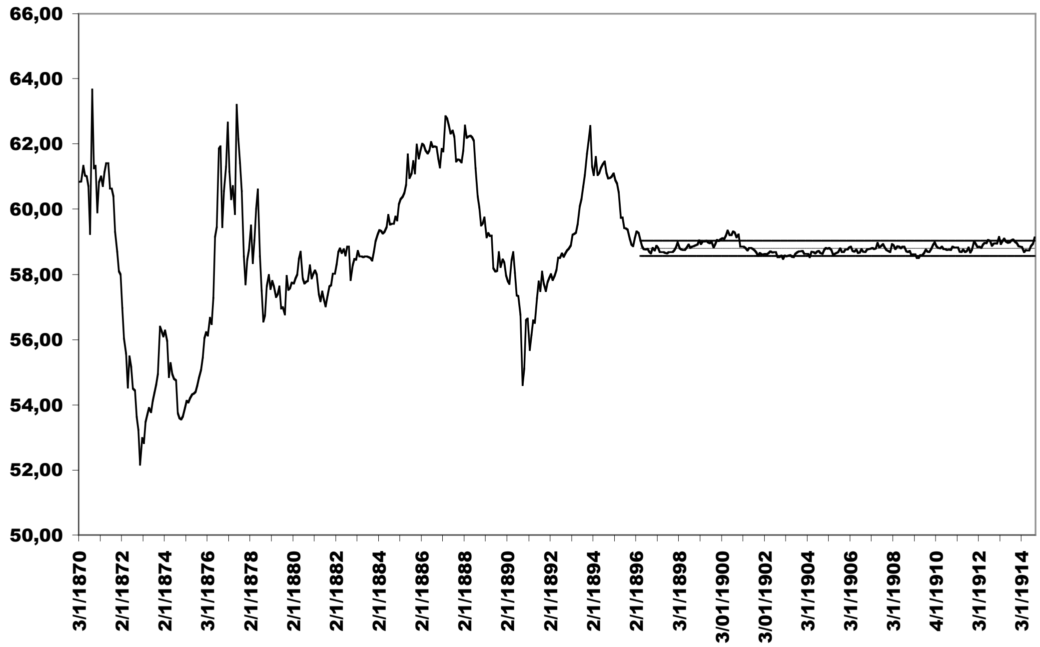


Figure 2.

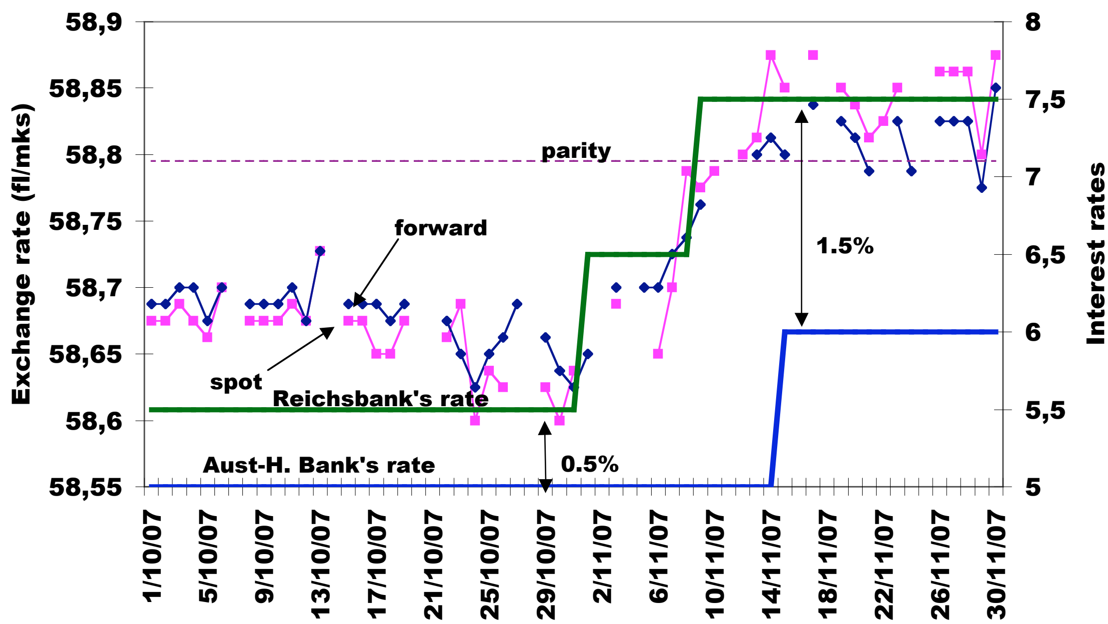


Figure 3.

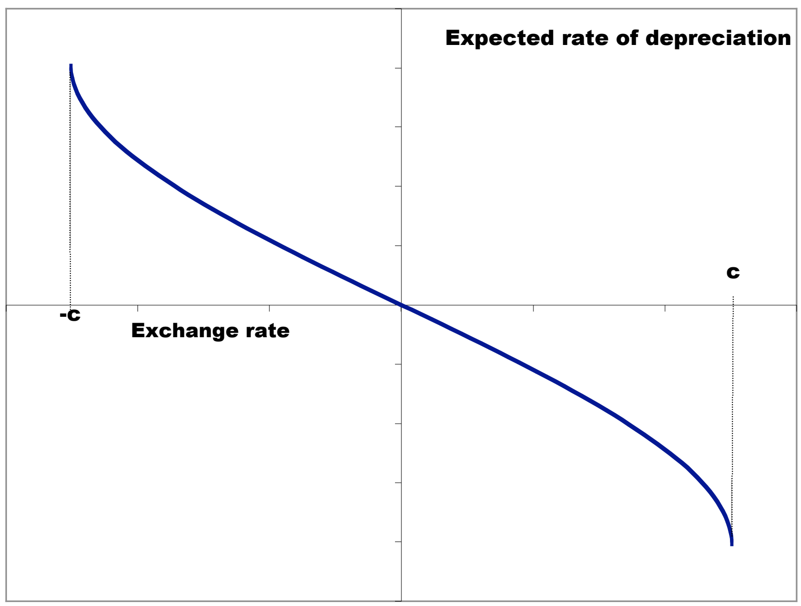
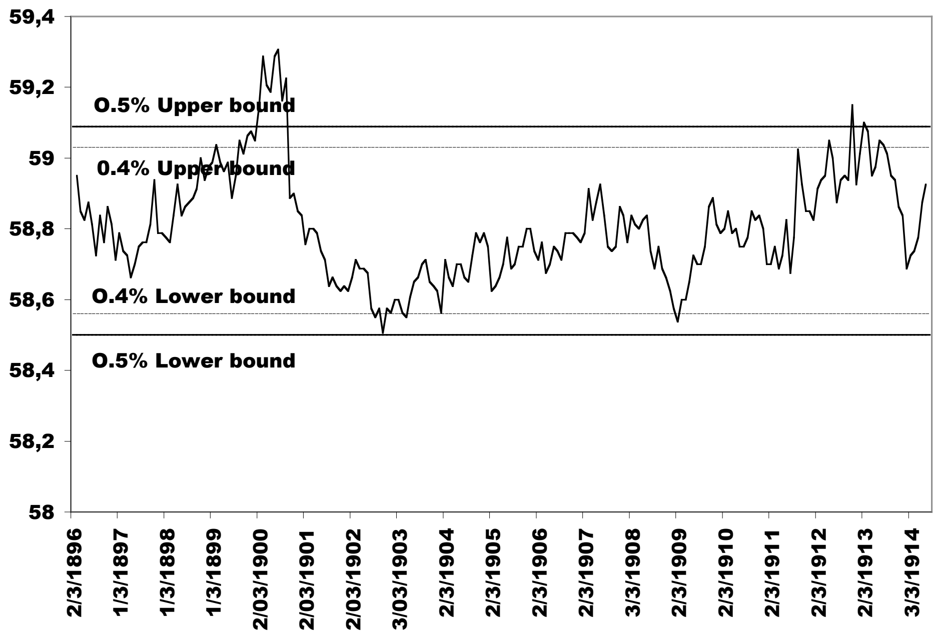


Figure 4.



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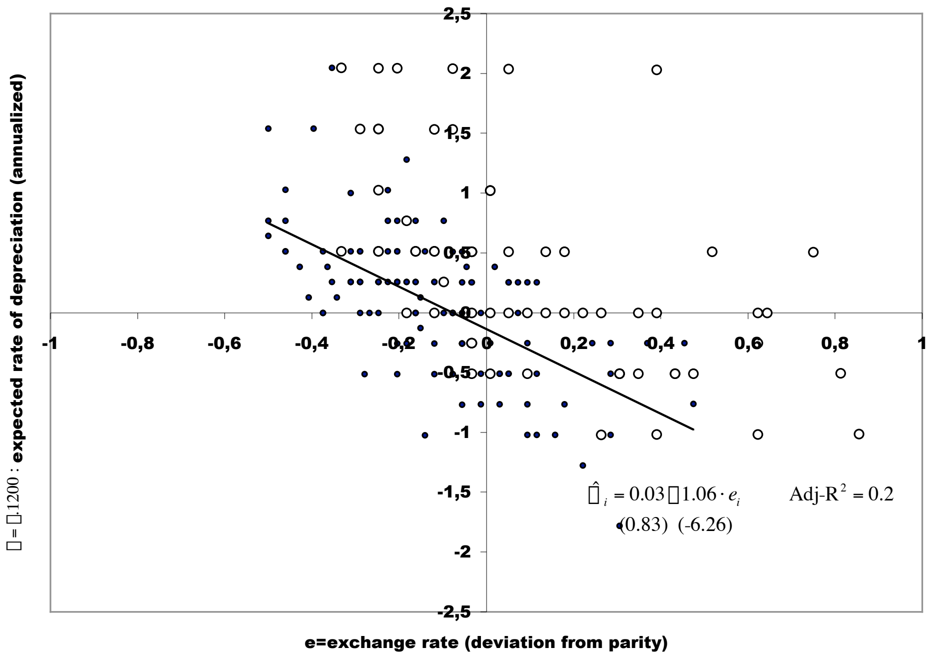

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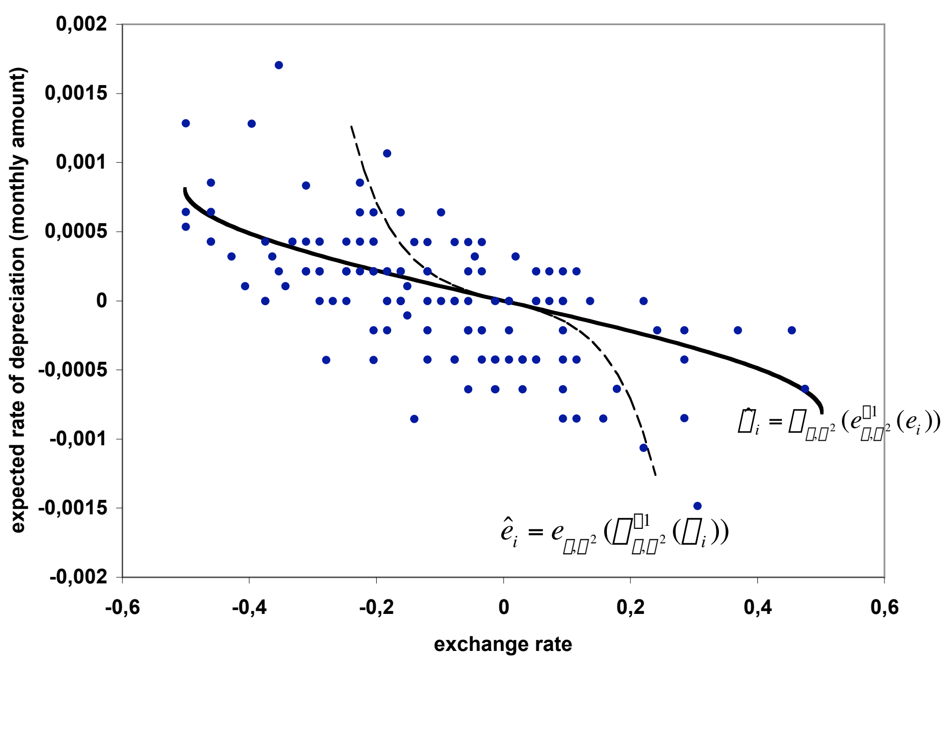
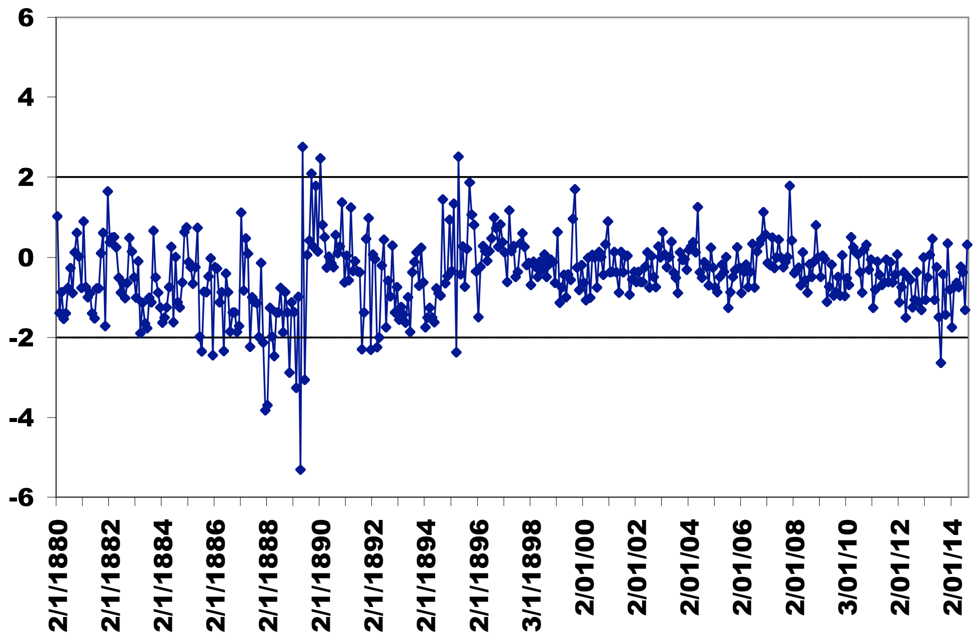


Figure 7.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