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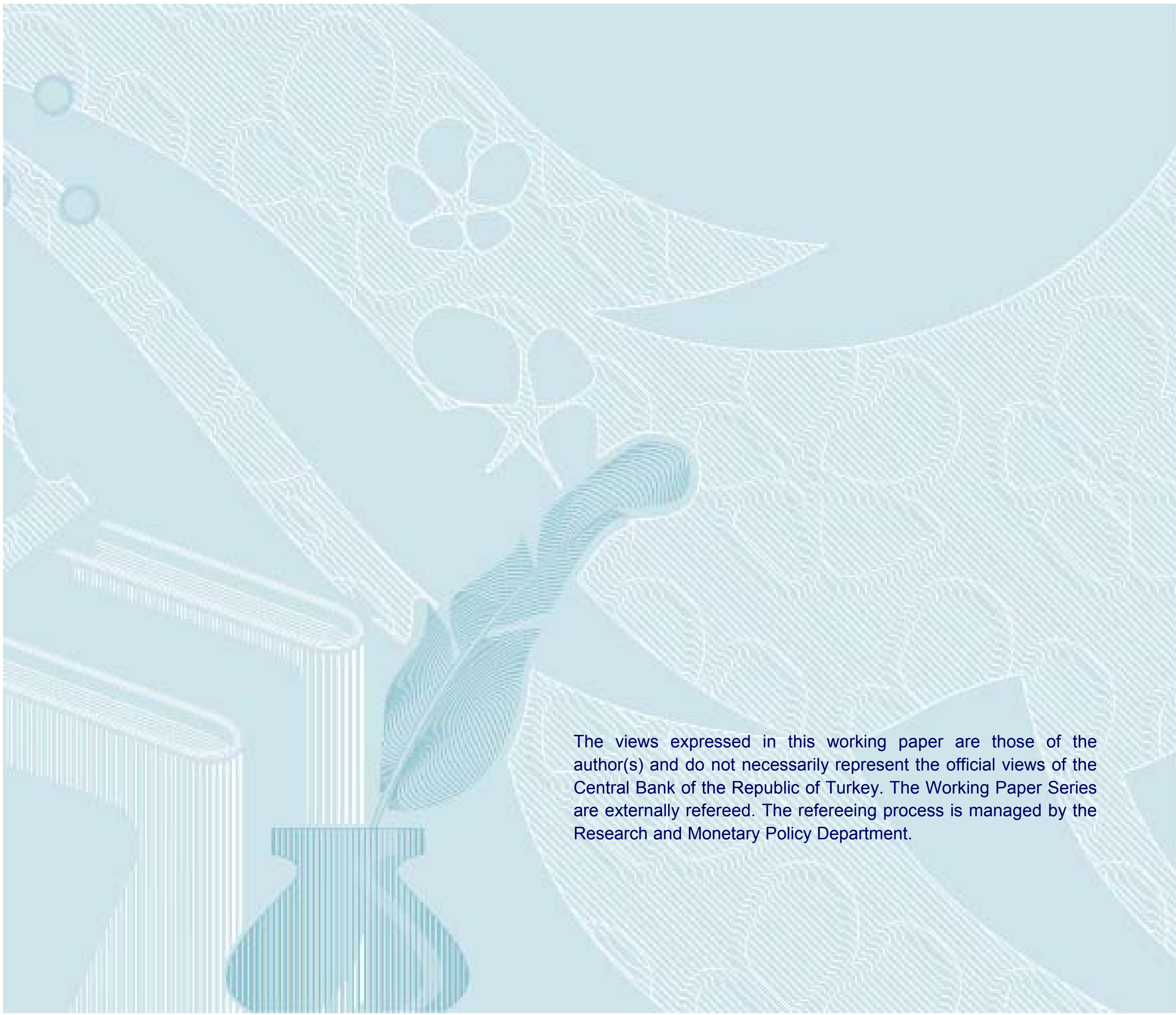

Are Swap and Bond Markets Alternatives to Each Other in Turkey?☆

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Abstract

Cross currency swaps are agreements to exchange interest payments and principals denominated in two different currencies and usually have one leg fixed and the other floating. The interest rate on the fixed leg is closely related to the yields on the securities of the same tenure and currency. In Turkey, cross currency swaps and treasury bonds have similar cash flow structures and risk profiles. Hence these markets are usually considered as alternatives to each other. In this context, using daily data for the period August 2008 – January 2012, this study investigates the level relationship between the cross currency swap rates and treasury bond yields of 1-month to 4-year tenures by the cointegration testing procedure suggested by Pesaran, Shin and Smith (PSS). Our empirical results indicate that, at shorter tenures, cross currency swap rates and treasury bond yields have a one-to-one long-run equilibrium relationship and hence the deviations from the equilibrium are quickly arbitraged away. On the other hand, the relationship becomes weaker as the tenure exceeds 6 months and completely disappears after 1 year. We also carry out some robustness checks and the results obtained from these analyses support our initial findings.

Keywords: covered interest parity, limits to arbitrage, bond market, currency swap, cointegration

JEL Classification: G12, G14, E43

☆ The views expressed in this paper are those of the authors and do not necessarily reflect the opinions of the Central Bank of Turkey.

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1. Introduction

In recent years the use of derivative products in the financial markets is steadily increasing. Compared to 1990s and before, investors have greater number of alternative markets and instruments to allocate their portfolios. This made financial markets more complicated, integrated and interrelated. However, the presence of arbitrage mechanism harmonizes the functioning of different financial markets and prevents persistent mispricing of different assets. In Turkey, the introduction of derivatives has important implications on financial markets as well. One of the widely debated links between derivatives and traditional financial markets is the one between cross currency swaps and treasury bonds which is the main focus of this study.

This study investigates the relationship between the TRY/USD cross currency swap market and the treasury bond market in Turkey by testing the covered interest parity (CIP) condition. To the best of our knowledge, this is the first study that attempts to test the swap-covered interest parity condition in Turkey and one of the very few studies carried out for emerging countries on this issue. In the related literature, most of the papers studying the arbitrage mechanism between the swap market and the bond market investigate deviations from the covered interest parity condition. Majority of the studies are carried out for advanced countries and usually find that covered interest parity condition holds in short tenures especially when transaction costs are taken into account, but does not hold in longer tenures. Some studies argue that the deviations from the covered interest parity are closely related with credit and liquidity risks and these factors affect the arbitrage mechanism more deeply in longer tenures.

Popper (1993) tests the swap-covered interest parity across the onshore markets of Canada, Japan, Germany, Switzerland, the United Kingdom, and the United States using weekly data from October 1985 to February 1988 and concludes that long-term financial capital is as mobile across these markets as is short-term capital since the covered interest parity holds in both short term and long term. Fletcher and Taylor (1996) also provide evidence that using currency swaps to cover exchange rate risk generally results in covered interest parity in the long-date markets, when allowance is made for transactions costs using data on the same countries over the period October 1985-March 1989. However they highlight that net deviations (in excess of transactions costs) are neither rare nor short-lived. Takezawa (1995) obtains similar results for the Canadian dollar, German mark, Japanese yen, Sterling pound and Swiss franc and concludes that long term covered interest parity holds when cross currency swap is used for hedging.

Batten and Szilagyi (2010) investigate the short-term covered interest parity relationship between the US dollar and the Japanese yen using a GARCH model on covered interest arbitrage profits and find evidence on considerable variation in CIP deviations from equilibrium. Moreover, these deviations tend to be one way and favor those with the ability to borrow US dollars. The authors further highlight that while CIP arbitrage opportunities persisted in the Yen forward market for many years—the likely effect of transaction costs and market segmentation—these opportunities have diminished and since 2000, almost disappeared most likely because of the recent use of electronic trading platforms.

Skinner and Mason (2012) investigate the covered interest parity for Brazil, Chile, Russia, South Korea, Norway and the United Kingdom and find that while covered interest rate parity holds for AAA rated economies at all maturities, it holds only at three-month maturity for emerging market economies. The study concludes that aspects of credit risk are the source of violations in CIP in the long-term capital markets rather than transactions costs or the size of the economy. Fong et al. (2010) also find that positive CIP arbitrage deviations include a compensation for liquidity and credit risk using a novel and unique dataset of tick-by-tick firm quotes for all financial instruments involved in the arbitrage strategy for HKD/USD market over the period May 2005-December 2005.

McBrady et al. (2010) and Habib and Joy (2010) study another aspect of the covered interest parity and test whether the firms believe in the CIP condition rather than testing whether the condition holds. Both papers investigate the determinants of currency choice in the issuance of foreign-currency-denominated bonds and test whether firm behavior is consistent with a belief in the covered and uncovered parity of interest rates. Interest rate parity asserts that ex-ante borrowing costs are similar across currencies such that borrowers have no incentive to seek borrowing cost advantages by selecting a low yield currency. While McBrady et al. (2010) provides evidence that is inconsistent with the interest parity conditions, Habib and Joy (2010) show that the choice of issuance currency is sensitive to deviations from uncovered interest parity but insensitive to deviations from covered interest parity which indicates that firms believe in covered interest parity. Another interesting finding of the former study is that bond yields and exchange rates systematically move toward parity following periods of relatively high issuance, and highlight that international corporate bond issuers, in fact, may effectively be the marginal traders who enforce interest rate parity at long horizons.

Our empirical results indicate that treasury bond and cross currency swap markets in Turkey are closely linked to each other in shorter tenures but the relationship becomes weaker as the tenure gets longer. Hence, the findings of this study are partially in line with the most of the studies in the related literature and provide evidence that supports the findings of Skinner and Mason (2012) regarding emerging countries.

The rest of the paper is organized as follows. Section 2 discusses the covered interest parity and the arbitrage mechanism in the bond markets and cross currency swap markets. Section 3 introduces the data and methodology employed. Section 4 reports the empirical results and Section 5 reports the robustness checks. Section 6 concludes.

2. The Structure of Swap-Covered Arbitrage

2.1. Swap-Covered Interest Parity

Swaps are relatively new financial instruments compared to other derivatives, as well as equities and debt securities. A swap involves exchanging the benefits of two financial assets in a specified future time period between two parties. There are various types of swaps which are actively used in financial markets, such as interest rate swaps, currency swaps and commodity swaps. In this paper, we focus on cross currency swaps and their use to cover exchange rate risk arising from foreign currency borrowing.

Cross currency swaps are agreements to exchange interest payments and principals denominated in two different currencies and usually have one leg fixed and the other floating. Usually the prices of cross currency swaps are quoted as the interest rate on the fixed leg against the LIBOR (London Interbank Offered Rate)[1] on the floating leg and the frequency of interest payments is one year (Hull, 2009). Thus, there are no intermediate cash flows if the tenure of the swap is shorter than one year. Considering these features, a swap payment stream mimics that of a bond that pays coupons annually. Cash flow structure of a cross currency swap with a notional amount of 1 unit of foreign currency is illustrated in Table 1.

[1] LIBOR is the average interest rate at which leading international banks in London are willing to lend each other money on a short term basis. Typically overnight, 1-month, 3-month, 6-month and 12-month LIBOR are quoted in all major currencies.

Table 1. Mechanics of a Cross Currency Swap[2]
(notional amount of cross currency swap is 1 unit of foreign currency)

	Cash Flows at Deal Date	Periodic Cash Flows	Cash Flow at Maturity
In Foreign Currency	-1	$+r_{f,t}$	+1
In Domestic Currency	$+S_0$	$-S_0.r_{d,0}$	$-S_0$

$r_{f,t}$ stands for the interest rate of the foreign currency (usually LIBOR) at time t, S_0 is the spot exchange rate and $r_{d,0}$ is the interest rate of the domestic currency at deal date.

By entering into a cross currency swap, both parties can hedge their foreign exchange risks or gain profits (or lose money) based on their own expectations regarding exchange rates of future. Thus, a cross currency swap can be used as an alternative tool to other foreign exchange derivative instruments for hedging and speculating in foreign exchange markets. The use of derivative instruments to cover exchange rate risk enables the comparison of the rates of return on assets denominated in different currencies. One of the most important international parity relations[3], the covered interest parity condition is based on this comparison. Assuming perfectly competitive foreign exchange markets for which there are no transactions costs or other market inefficiencies, the covered interest parity condition is usually illustrated in standard textbooks by using forward contracts. A currency forward contract is an agreement between two parties to buy/sell a specified amount of a currency at a specified future time at an exchange rate agreed today. An investor must receive the same return from investing in a domestic asset or investing in a foreign asset with a similar risk and cash flow structure by hedging the exchange rate risk with a forward contract. Otherwise, covered interest arbitrage will be profitable. Thus, the CIP condition can be expressed as:

[2] Note that the last periodic cash flows also take place at the maturity but they are not included in the last column of the table since the last column illustrates only the exchange of the principal amounts. We intentionally prefer this representation in order to avoid confusion in the following illustrations regarding the arbitrage mechanism using the cross currency swaps and treasury bonds in Section 3.2.

[3] Basic international parity relations are the Purchasing Power Parity, the Fisher Relation, the International Fisher Effect (Uncovered Interest Parity), the Covered Interest Parity and the Unbiasedness of Forward Rates (Copeland et al. 2005).

$$(1+r_d)^t = (1+r_f)^t F_{0,t}/S_0. \quad (1)$$

Here, r_d and r_f stand for the domestic and the foreign interest rates respectively, S_0 is the spot exchange rate and $F_{0,t}$ is the t-year forward exchange rate at deal date.

When using currency or cross currency swaps to hedge the exchange rate risk, the covered interest arbitrage is slightly more complicated. Again assuming perfectly competitive foreign exchange markets, the swap-covered parity condition comes from equating a domestic currency return with a comparable covered foreign currency return. An investor may invest in a domestic asset and earn the domestic rate of return, r_d. Alternatively, the investor may invest in a foreign asset and hedge the exchange rate risk with a (cross) currency swap. In this case, the rate of return is the sum of foreign rate of return and the net swap payments (Popper, 1993). Thus, the CIP condition can be expressed as:

$$r_d = r_f + r_{s,d} - r_{s,f}. \quad (2)$$

Here, $r_{s,d}$ and $r_{s,f}$ stand for the interest rates on the domestic currency and the foreign currency legs of the (cross) currency swap contract respectively.

2.2. Arbitrage in Cross Currency Swap and Bond Market

Cross currency swaps enable local banks and investors to convert funds in foreign currency obtained from foreign institutions to local currency in an almost risk-free manner so that they can invest in local assets. The local investor hedges the loan amount obtained from foreign institutions with the help of the cross currency swap and also hedges the interest payments of the loan to a large extent. The spread between the yield on local assets and the swap rate determines the profits. Theoretically, this spread is expected to be arbitraged away by rational investors.

Table 2 provides an example of the cash flow structure of an arbitrage relation between cross currency swaps and treasury bonds.

Table 2. Cash Flows from Hedging Foreign Currency Risk Using a Swap
(notional amount of cross currency swap is 1 unit of foreign currency)

	Cash Flows at Deal Date		**Periodic Cash Flows**		**Cash Flow at Maturity Date**	
Simultaneous transactions	Domestic Currency	Foreign Currency	Domestic Currency	Foreign Currency	Domestic Currency	Foreign Currency
i) Borrowing from international markets		+1		$-LIBOR_t$		-1
ii) Entering into a cross currency swap	$+S_0$	-1	$-S_0.r_s$	$+LIBOR_t$	$-S_0$	+1
iii) Purchasing a domestic currency treasury bond	$-S_0$		$+S_0.r_g$		$+S_0$	
Overall	**0**	**0**	$\mathbf{+S_0.(r_g-r_s)}$	**0**	**0**	**0**

r_g stands for the annual yield of domestic currency denominated treasury bond and r_s stands for the swap rate (annual yield of the domestic currency leg of a cross currency swap). S_0 is the spot exchange rate at deal date.

In this simplified example, it is assumed that the rate of borrowing from foreign institutions is equal to the interest rate on the floating leg of the cross currency swap and both are equal to LIBOR. It is also assumed that the cross currency swap has annual interest payments. The bottom row of Table 2 shows the overall cash flows at deal date, at each periodic payment date and at the maturity. The only net cash flow that can be different than zero is the periodic cash flows in the domestic currency.[4] The investor gains or loses money based on the difference between the treasury bond yield and the swap rate which is called the swap spread.

However, in real life, there are some obstacles in the arbitrage mechanism that are neglected in standard textbook examples of arbitrage. First of all, there are transaction costs and different trading hours, settlement dates and delivery terms in different financial markets. Moreover, not all of the arbitrage transactions are riskless but most of them involve fundamental or non-

[4] The cash flow structure illustrated in Table 2 may change due to the frequency of the periodic payments of the treasury bond or the cross currency swap.

fundamental risks[5] to some extent (Gromb and Vayanos, 2010). There are also legal constraints on short-selling of some assets. Another type of legal constraints is that some of the institutional investors such as mutual funds, real estate investment trusts, pension funds, etc. have the obligation to invest in only certain types of assets.

Besides of these limitations, one of the most important factors that limit the arbitrage mechanism is the financial constraints of the arbitrageur. The arbitrageur needs capital to initiate and maintain the transactions. In most of the cases even though the arbitrageur makes profit in the long-run for sure, she may lose money in the short-run and hence she needs capital to maintain her position (Shleifer and Vishny, 1997). If she does not have deep enough pockets to always access to capital, she may run out of money and have to liquidate her position at a loss. In reality, arbitrage is commonly conducted by relatively few number of professional and highly specialized investors who combine their knowledge with resources of outside investors to take large positions. These investors manage other people's money. However, these people evaluate their money manager’s performance and competency by current profits or losses so that they may withdraw some of their capital in the middle of profitable arbitrage transactions (Shleifer and Vishny, 1997). This behavior discourages money managers from investing in longer term and risky arbitrage transactions, even though the expected returns from the trade are high.

When it comes to the arbitrage between cross currency swaps and treasury bonds, there are some additional differences that may distort the link between these two markets. First of all, the risk premiums of investors that enter into the cross currency swap may be different due to firm and country specific factors so that the borrowing cost of the investor that raises funds from

[5] Fundamental risk is the risk borne by arbitrageurs arising from payoffs of different assets which are simultaneously bought or sold in the arbitrage transaction. Non-fundamental risk is the risk caused by noise-traders (DeLong et al. 1990)

international markets may be higher than LIBOR. In this case, the net cash flow from the "borrow in foreign currency-hedge by swap-purchase domestic asset" scheme changes as illustrated in Table 3.

Table 3. Cash Flows from Hedging Foreign Currency Risk Using a Swap
(notional amount of cross currency swap is 1 unit of foreign currency, borrowing costs of firms are different)

	Cash Flows at Deal Date		**Periodic Cash Flows**		**Cash Flow at Maturity Date**	
Simultaneous transactions	Domestic Currency	Foreign Currency	Domestic Currency	Foreign Currency	Domestic Currency	Foreign Currency
i) Borrowing from international markets		+1		-($LIBOR_t$+p)		-1
ii) Entering into a cross currency swap	+S_0	-1	-$S_0.r_s$	+$LIBOR_t$	-S_0	+1
iii) Purchasing a domestic currency treasury bond	-S_0		+$S_0.r_g$		+S_0	
Overall	**0**	**0**	**+$S_0.(r_g-r_s)$**	**-p**	**0**	**0**

r_g stands for the annual yield of domestic currency denominated treasury bond, r_s stands for the swap rate (annual yield of the domestic currency leg of a cross currency swap) and p stands for the risk premium over LIBOR in borrowing from the international markets. S_0 is the spot exchange rate at deal date.

This creates an additional cost and also an exchange rate risk for the investor. As the tenure of the treasury bond and the cross currency swap gets longer, the exchange rate risk increases. Thus, the exchange rate risk is one of the factors that may distort the relation between the cross currency swaps and treasury bonds. Factors such as inflation expectations, monetary policy stance and risk premiums affect exchange rates and hence can cause swap rates and treasury bond yields to diverge. Another difference between the cross currency swaps and the treasury bonds stems from the counterparty risk. In the case of default in treasury bonds, the investor loses her initial investment. On the other hand the notional amounts are exchanged initially in cross currency swaps and hence in the case of default, the investor only loses the profit she would make from the changes in exchange rates. Taking all these limitations to arbitrage into account, as long as these factors are of a negligible size, the cross currency swap market and the treasury bond market can be considered as alternatives to each other.

3. Data and Methodology

3.1. Data

In our empirical set-up, we are looking for a long-run equilibrium relation between the Turkish lira interest rates on TRY/USD cross currency swaps and Turkish lira denominated treasury bonds of the same tenure. If there exists any long-run relation between the returns, then any deviation from equilibrium will be temporary. We test the long-run equilibrium relation between series is the cointegration analysis. A series, which needs to be differenced d times before it has a stationary invertible ARMA representation, is said to be integrated of order d (Hall et al. 1992). If some linear combination of two or more series that are not stationary yields a stationary series, then there exists a cointegration between the series. This implies that deviations from equilibrium are stationary, with finite variance, even though the series themselves are non-stationary and have infinite variance (Engle and Granger, 1987). In other words, if there exists a cointegration relation, then the series do not diverge away from each other.

We employ the cointegration analyses in order to test whether there exists a level relationship between treasury bond yields and swap rates. We use daily closing data on treasury bonds issued by the Turkish Treasury of 1, 2, 3, 6, 9, 12, 24, 36 and 48-month tenures and TRY/USD cross currency swap rates of the same tenures. We obtain the cross currency swap rates from Bloomberg and treasury bond yields from the daily bulletins of Istanbul Stock Exchange (ISE). The sample covers approximately three and a half years, from August 6, 2008 to January 25, 2012.[6] But, since actual treasury bond yields for fixed tenures are not observable every day, we obtain the data indirectly by estimating a yield curve each day by the Extended Nelson-Siegel (ENS) Method. Yield curve estimations are performed by using the data obtained from the daily

[6] Total number of observations is 871.

bulletins of ISE.[7] Estimated yield curve shows the yields on zero-coupon bonds for different tenures. Our yield curve estimations are based on minimizing the difference between observed prices and yield curve implied prices similar to the approach adopted by Akıncı et al. (2007). Despite the fact that the ENS Method is a very convenient approach to estimate the yield curve; its curve fitting ability is considerably poor for very short tenures up to 6 months. Thus, we obtain 1, 2, 3 and 6-month yields by linear interpolation.[8] All series used in this study is depicted in Figure 1.

Since our data are at daily frequency, a cointegration formulation assumes the deviations from equilibrium (i.e. arbitrage opportunities) are to be corrected on a daily basis. This is a reasonable time period since one day is long enough for arbitrageurs to respond to any disequilibrium between bond yields and swap rates. In addition, one day is not too long so that our specification leaves only the arbitrage opportunities that arise and disappear within a day, out of account. Therefore, it is quite sensible to think that this specification can capture most of the deviations from equilibrium.

3.2. Cointegration Testing Procedure

There are several procedures suggested in the related literature to test for cointegration. In this study, we employ the cointegration testing procedure proposed by Pesaran, Smith and Shin (henceforth PSS) (2001). But we also carry out Engle-Granger's (henceforth EG) two step procedure (Engle and Granger, 1987) and the Johansen procedure (Johansen and Juselius, 1990) as robustness checks.

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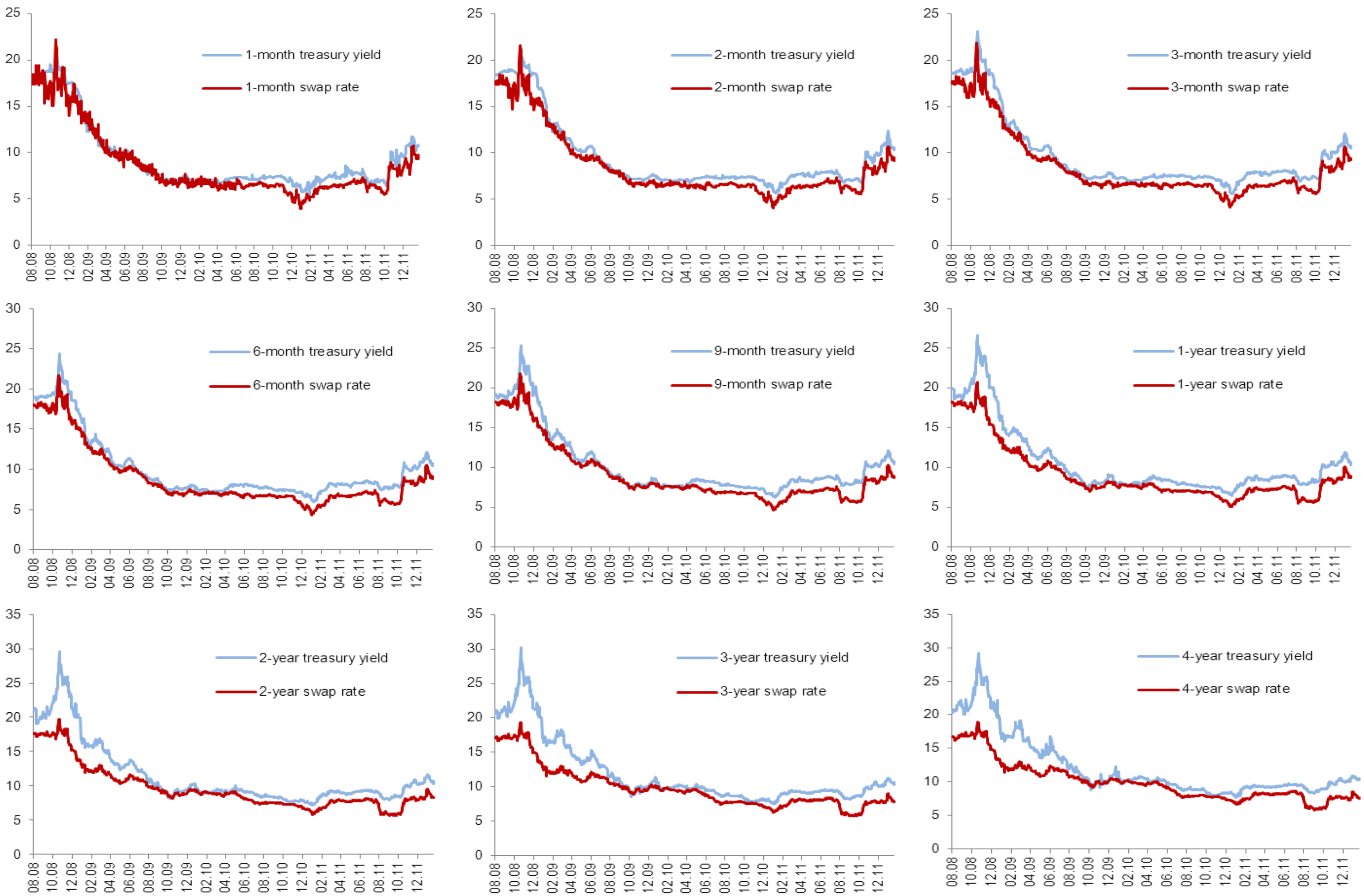
[7] For more detailed information regarding the data that are suitable for yield curve estimation in Turkey, see Akıncı et al. (2007).

[8] For instance, we calculate 1-month yield as; $r_1 = r_L + \frac{30-T_L}{T_L-T_U}(r_L - r_U)$, where T_L denotes the time to maturity and r_L denotes the annually compounded yield of the bond whose time to maturity is closest to 30 days from down; T_U denotes the time to maturity and r_U denotes the annually compounded yield of the bond whose time to maturity is closest to 30 days from up.

Figure 1. Time Series Plots of Treasury Bond Yields and Swap Rates



Source: Central Bank of Turkey, Istanbul Stock Exchange, Bloomberg

The procedure proposed by Pesaran et al. (2001) develops a new approach to the problem of testing the existence of a level relationship between a dependent variable and a set of regressors when it is not known with certainty whether the underlying regressors are trend or first difference stationary. The test is based on the estimation of an unrestricted error correction model of the form;

$$\Delta Y = \Delta X\delta + \gamma Y_{-1} + \theta X_{-1} + \varepsilon \tag{3}$$

Or more generally by adding lagged values of ΔY and ΔX to Model 3;

$$\Delta Y = \sum_{i=0}^{p} \Delta X_{-i}\delta_i + \sum_{j=1}^{q} \Delta Y_{-j}\varphi_j + \gamma Y_{-1} + \theta X_{-1} + \varepsilon \tag{4}$$

Pesaran et al. (2001) develops a bounds test approach to test the significance of the lagged levels of the variables. They provide the critical F values to test the null hypothesis that $\gamma=\theta=0$ and also critical t values to test the null hypothesis that $\gamma=0$. These critical values are different than the standard F and t critical values since the asymptotic distributions of these statistics are non-standard under the null hypothesis that there exist no level relationship irrespective of whether the regressors are I(1) or I(0). The proposed tests fail to reject the null when the standard F-statistic (t-statistic) is less (greater) than the lower (upper) bound of the critical F value (t value) and reject the null if the standard F-statistic (t-statistic) is greater (less) than the upper (lower) bound of the critical F value (t value). On the other hand, if the F-statistic (t-statistic) falls between the upper and lower bounds of the critical values, then the test becomes inconclusive.

Major shortcomings of PSS procedure stem from the fact that PSS procedure is based on a single equation error correction model. Hence, it allows for only one cointegration relation[9] and it has an asymmetric specification. If there is no economic theory that determines the dependent and the

[9] This is not an important shortcoming in two variable cases since the number of cointegration relations can not exceed the number of series.

explanatory variables, then one of the variables has to be chosen arbitrarily. Contradicting results may be obtained in such a situation. However, this procedure has some important advantages over the EG and the Johansen procedures which are the two most widely used cointegration testing procedures. Unlike the EG procedure, PSS procedure is carried out in a single step due to the fact that there is no restriction on the long-run equilibrium coefficients of the error correction model in this procedure. In the EG procedure there are two steps and the second step is based on the estimated rather than the (unobservable) true residuals. Thus, potential errors in the estimated level regression may be carried to the second step and hence distort the results of the test. Moreover, compared to the Johansen procedure, the PSS procedure is more convenient for two variable cases since, under some circumstances, trace and maximum eigenvalue tests in the Johansen procedure are biased towards rejecting a true null hypothesis more often than the asymptotic theory suggests. This bias is greater when the sample size is smaller, when the lag length is longer and when the cointegration relation is highly serially correlated (Jacobson, 1995; and Eriksson, 2004). Finally, one of the most important advantages of the PSS procedure is that it does not require the individual series to be integrated of the same order.

4. Empirical Results

In our empirical setting, we test the existence of long-run equilibrium relationship between the treasury bond yields and the cross currency swap rates of different tenures. In addition, if there exist a cointegration relation, then we expect that the cointegrating vector to be close to [b, -b, c], with b being the error correction coefficient and c being a stable intercept term that proxies the effects of the risk premium differential between the parties of the cross currency swap on the equilibrium relation. This vector implies that the cross currency swap rates are almost equal to treasury bond yields of the same tenure at long-run equilibrium.

Before testing for cointegration, we believe that it is more convenient to determine the degree of integration of each series. Hence, we perform three different unit root tests for each series. These tests are Augmented Dickey Fuller test (ADF), Generalized Least Squares based Dickey-Fuller test (DFGLS) and Kwiatkowski-Phillips-Schmidt-Shin test (KPSS).[10] ADF test is the most commonly used unit root test where DFGLS test is an extension to the ADF test in terms of power and finally the KPSS test is a very convenient complementary to the ADF test since its null is the case of stationarity. Thus, DFGLS and KPSS tests are carried out as robustness checks. It is possible to carry out the ADF test with or without exogenous intercepts and trends. Hence there are three different possible test equation specifications. Also DFGLS and KPSS tests can be carried out with or without exogenous trends in the test equations. The results of all possible specifications of ADF, DFGLS and KPSS unit root tests for the levels are reported in Table 4.

ADF with intercept, DFGLS and KPSS tests indicate that none of the series is stationary in levels. But ADF tests without intercept exhibit a tendency towards rejecting the hypothesis that the series are not stationary. Nonetheless, we accept what the majority of the tests indicate and regard the levels as non-stationary. Next, we test the stationarity of first differences. The results are reported in Table 5.

According to the ADF test results given in Table 5, all first differences are stationary whereas DFGLS tests conclude that 1-month, 2-month and 3-month swap rates are not stationary. Furthermore the KPSS test carried out without exogenous trend indicates that most of the first differences are non-stationary but when we include exogenous trend in KPSS test equation, the results change so that the series are found to be stationary.

[10] For detailed information on these tests see Dickey and Fuller (1979), Dickey et al. (1986), Kwiatowski et al. (1992), Elliott et al. (1996).

Table 4. Unit Root Tests for Levels

	ADF Test			DFGLS Test		KPSS Test	
Specification	No intercept	Intercept-No trend	Intercept and trend	Intercept-No trend	Intercept and trend	Intercept-No trend	Intercept and trend
1M - T-Bond	-2.136**	-2.510	-0.642	0.133	0.153	1.888***	0.753***
1M - Swap rate	-2.763***	-3.251**	-0.844	0.230	0.245	2.200***	0.791***
2M - T-Bond	-1.979**	-2.550	-1.044	0.014	-0.187	1.886***	0.757***
2M - Swap rate	-2.842***	-3.369**	-0.921	0.279	0.314	2.134***	0.776***
3M - T-Bond	-2.174**	-2.569*	-0.984	0.160	-0.065	1.860***	0.749***
3M - Swap rate	-2.415**	-2.866**	-0.811	0.227	0.147	2.094***	0.763***
6M - T-Bond	-1.946**	-2.442	-1.299	0.012	-0.480	1.868***	0.752***
6M - Swap rate	-2.570***	-2.881**	-0.852	0.075	-0.466	2.225***	0.757***
9M - T-Bond	-2.048**	-2.332	-1.065	0.151	-0.325	1.905***	0.744***
9M - Swap rate	-2.173**	-2.598*	-1.401	0.185	-0.464	2.360***	0.743***
1Y - T-Bond	-2.045**	-2.355	-1.236	0.144	-0.465	1.956***	0.732***
1Y - Swap rate	-2.420**	-2.865*	-1.458	0.344	-0.241	2.279***	0.713***
2Y - T-Bond	-1.971**	-2.141	-1.244	0.182	-0.690	2.200***	0.716***
2Y - Swap rate	-1.934*	-2.124	-1.286	0.154	-0.746	2.209***	0.715***
3Y - T-Bond	-1.605	-1.761	-1.234	0.071	-1.021	2.387***	0.725***
3Y - Swap rate	-2.452**	-2.491	-1.797	0.662	-0.773	2.845***	0.590***
4Y - T-Bond	-1.802*	-1.908	-1.289	0.097	-1.077	2.516***	0.739***
4Y - Swap rate	-2.355**	-2.247	-1.933	0.712	-1.038	2.947***	0.535***

Sample period: 06.08.2008 – 25.01.2012
(*): significant at 10% level, (**): significant at 5% level, (***): significant at 1% level.

When we evaluate the results of Table 4 and Table 5 together, most of the series are integrated of order one or near-integrated of order one. In this case, the PSS procedure appears as an appropriate way of testing for cointegration. We previously discussed in section 3.2 that this procedure is asymmetric in a sense that one of the variables must be chosen as dependent and the rest as independent. If there exist an economic theory or any other a priori information or expectation regarding the direction of the relationship between the variables, it is possible to pick one of the variables as dependent and ignore the other alternatives. But, we do not have such a theoretical expectation or preliminary information regarding the direction of the relationship. Furthermore, it is possible to construct the underlying unrestricted error correction model with or without an exogenous intercept in the PSS procedure. Inclusion of the intercept term modifies the

CIP relation to take the risk premium into account. In the end, since we have two variables (swap rate and treasury bond yield), and two alternatives regarding the inclusion of an intercept, we carry out the PSS procedure using a total of four different possible specifications for each tenure.

Table 5. Unit Root Tests for First Differences

	ADF Test			**DFGLS Test**		**KPSS Test**	
Specification	No intercept	Intercept-No trend	Intercept and trend	Intercept-No trend	Intercept and trend	Intercept-No trend	Intercept and trend
1M - T-Bond		-34.111***	-34.431***	-7.719***	-33.900***	0.949***	0.050
1M - Swap rate			-13.972***	-0.309	-1.824	0.684**	0.032
2M - T-Bond		-10.126***	-10.533***	-10.051***	-10.092***	0.970***	0.056
2M - Swap rate			-13.163***	-0.662	-1.761	0.467**	0.018
3M - T-Bond			-22.383***	-22.084***	-22.191***	0.811***	0.050
3M - Swap rate			-14.546***	-1.281	-2.612*	0.490**	0.022
6M - T-Bond		-13.332***	-13.556***	-9.965***	-11.594***	0.667**	0.048
6M - Swap rate			-13.577***	-2.813***	-4.957***	0.838***	0.026
9M - T-Bond		-25.472***	-25.647***	-3.240***	-10.853***	0.550**	0.049
9M - Swap rate			-14.601***	-13.881***	-14.058***	0.641**	0.034
1Y - T-Bond		-24.625***	-24.772***	-2.728***	-8.301***	0.493**	0.047
1Y - Swap rate			-23.582***	-2.969***	-22.663***	0.801***	0.034
2Y - T-Bond		-29.773***	-29.869***	-2.403**	-3.632***	0.407*	0.044
2Y - Swap rate		-30.322***	-30.414***	-2.427**	-3.662***	0.364*	0.042
3Y - T-Bond	-10.650***	-10.701***	-10.777***	-2.176**	-7.880***	0.279	0.043
3Y - Swap rate		-26.049***	-26.148***	-25.983***	-26.119***	0.388*	0.037
4Y - T-Bond		-12.713***	-12.799***	-2.215**	-3.734***	0.221	0.041
4Y - Swap rate		-25.890***	-25.952***	-24.581***	-25.805***	0.285	0.036

Sample period: 06.08.2008 – 25.01.2012
(*): significant at 10% level, (**): significant at 5% level, (***): significant at 1% level.

Table 6 reports the PSS cointegration test results along with the information regarding the lag length specification and the estimates of the cointegrating vectors.

Estimation results in Table 6 indicate that swap rates and treasury bond yields are cointegrated in shorter tenures but the statistical significance of the cointegration relationship and the degree of partial adjustment[11] diminish as the tenure increases and the long-run relationship disappears roughly after 1 year. This is in line with the findings of Skinner and Mason (2012) regarding

[11] Magnitude of the error correction coefficient.

emerging countries. Short term interest rates and yields are mainly determined by the actual and expected monetary policy actions in the near future. On the other hand, as tenure increases, risk factors such as credit risk and liquidity risk also increase as suggested by Skinner and Mason (2012) and Fong et al. (2010). These factors along with the other factors that are discussed in Section 2.2 may influence the swap rates and the treasury bond yields in different directions and magnitudes. Furthermore, the statistical significance of the cointegration relationship is higher when the dependent variable is the swap rate. This implies that the direction of causality, or at least the direction of the arbitrage mechanism may be from treasury bond yields to swap rates. This makes sense since the banks and the foreigners in Turkey usually respond to movements in treasury bond yields by cross currency swap transactions and not vice versa. In addition, it is easy to take short or long position in swaps but this is not the case for treasury bonds since short selling of treasury bonds is difficult in Turkish financial markets.

Another interesting finding of our analysis is that the long-run equilibrium relations between swap rates and bond yields are almost one-to-one.

For instance, the cointegrating vector of 1-month swap rate and 1-month treasury bond yield, when the swap rate is the dependent variable and there is an exogenous intercept in the error correction model is [-0.154, 0.142, -0.026]. This can be expressed as follows;

$$0.154 \times r_{S,1} = -0.026 + 0.142 \times r_{T,1}$$

$$\Rightarrow \quad r_{S,1} = 0.922 \times r_{T,1} - 0.169$$

where $r_{S,1}$ is the 1-month swap rate and $r_{T,1}$ is the 1-month treasury bond yield. Similarly the long-run regression coefficients for each specification and tenure can be recovered by dividing the coefficient of treasury bond yield to the coefficient of the swap rate and then multiplying the quotient by (-1). Figure 2 depicts the long-run equilibrium coefficients calculated for each specification and tenures up to 1 year.

Table 6. Pesaran-Shin-Smith Cointegration Test Results

	Cointegration Tests		Cointegrating Vector			Lag Specification		
	t-Stat	F-Stat	Swap rate	Treasury bond yield	Intercept	Optimal lag length[I]	LM(1)	LM(5)
Specification	**Dependent: Swap rate; no intercept**							
1 month	-5.735***	18.133***	*-0.148*	0.135	0.000	11	1.36	3.72
2 months	-4.930***	13.914***	*-0.106*	0.094	0.000	11	0.10	5.66
3 months	-6.189***	20.352***	*-0.096*	0.084	0.000	3	1.43	6.50
6 months	-3.323***	7.694***	*-0.035*	0.030	0.000	12	2.58	8.58
9 months	-1.854	4.166**	*-0.014*	0.012	0.000	15	0.00	2.43
1 year	-0.820	4.677**	*-0.005*	0.003	0.000	10	2.61	9.15
2 years	0.331	2.889	*0.001*	-0.002	0.000	1	2.37	3.94
3 years	0.189	2.773	*0.001*	-0.001	0.000	1	0.77	4.96
4 years	0.079	2.600	*0.000*	-0.001	0.000	1	0.00	5.37
Specification	**Dependent: Swap rate; intercept in CE**							
1 month	-5.624***	17.559***	*-0.154*	0.142	-0.026	11	1.32	3.68
2 months	-4.695***	13.206***	*-0.108*	0.096	-0.006	11	0.09	5.78
3 months	-6.157***	20.339***	*-0.102*	0.092	-0.023	3	1.40	6.80
6 months	-3.026*	6.737**	*-0.033*	0.028	0.007	12	2.62	8.77
9 months	-1.777	4.741	*-0.014*	0.009	0.026	15	0.15	2.99
1 year	-1.143	6.601**	*-0.008*	0.002	0.038	13	0.00	2.00
2 years	-1.073	3.916	*-0.006*	0.001	0.033	1	2.69	4.23
3 years	-1.219	3.289	*-0.007*	0.002	0.035	1	1.02	4.99
4 years	-1.165	2.614	*-0.006*	0.002	0.034	1	0.02	5.38
Specification	**Dependent: Treasury bond yield; no intercept**							
1 month	-2.085	3.008	0.022	*-0.022*	0.000	4	0.00	7.81
2 months	-2.922**	4.915**	0.025	*-0.023*	0.000	5	0.00	5.23
3 months	-2.893**	4.426**	0.027	*-0.025*	0.000	6	0.55	3.50
6 months	-2.509*	3.150	0.021	*-0.019*	0.000	7	1.48	3.17
9 months	-2.705**	3.729*	0.021	*-0.019*	0.000	15	0.17	5.73
1 year	-2.939**	5.029**	0.022	*-0.018*	0.000	5	0.00	2.07
2 years	-1.865	2.276	0.014	*-0.011*	0.000	5	2.22	7.67
3 years	-1.978	2.131	0.014	*-0.011*	0.000	8	1.89	4.69
4 years	-1.893	1.795	0.016	*-0.013*	0.000	6	1.74	9.00
Specification	**Dependent: Treasury bond yield; intercept in CE**							
1 month	-2.848	5.168*	0.030	*-0.033*	0.043	4	0.00	8.10
2 months	-3.746**	7.974***	0.032	*-0.033*	0.032	5	0.58	5.40
3 months	-3.608**	6.921**	0.035	*-0.035*	0.029	6	0.96	3.97
6 months	-3.016*	4.645	0.026	*-0.025*	0.024	7	2.03	3.67
9 months	-2.726	3.770	0.021	*-0.019*	0.006	15	0.18	5.80
1 year	-3.045*	6.644**	0.026	*-0.019*	-0.028	6	0.83	5.26
2 years	-3.136*	6.414**	0.033	*-0.021*	-0.074	7	0.04	1.67
3 years	-2.640	3.826	0.026	*-0.016*	-0.061	8	2.38	4.99
4 years	-2.247	2.536	0.026	*-0.017*	-0.053	9	1.41	9.22

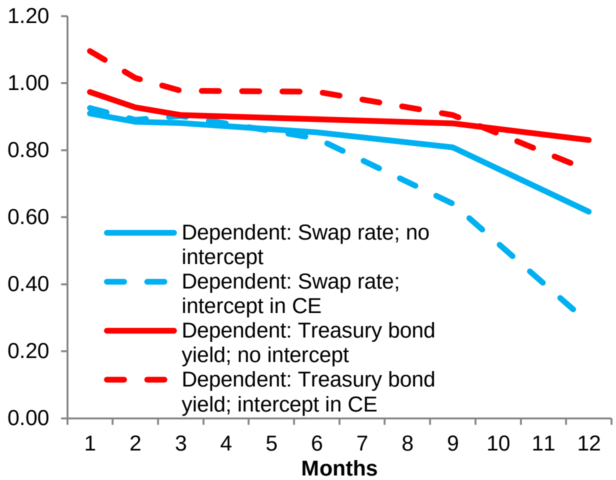
Sample period: 06.08.2008 – 25.01.2012.

Values written in italics represent the corresponding error correction coefficients for each specification and tenure.

(*): significant at 10% level, (**): significant at 5% level, (***): significant at 1% level.

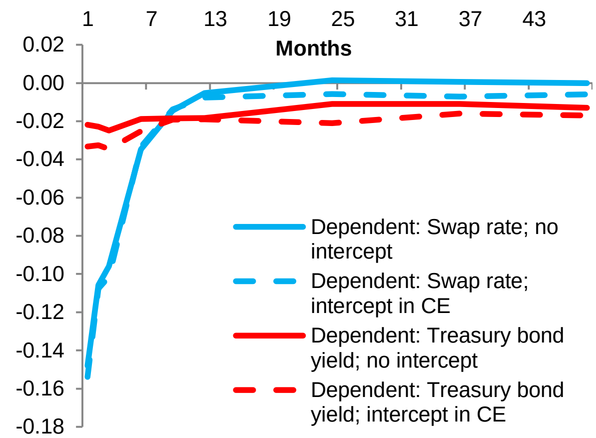
[I] The lag length which minimizes the Schwarz information criterion among the lag length specifications which eliminate the autocorrelation up to 5th order (1-week).

Figure 2. Long-Run Equilibrium Coefficients*[12]



*Expressed as the ratio of the coefficients of swap rate to treasury bond yield in the cointegrating vector

Figure 3. Error Correction Coefficients



The most important information contained in the cointegrating vector is the error correction coefficient. This coefficient shows the proportion of the disequilibrium from one period that is corrected in the next period (Engle and Granger, 1987). Since our data are at daily frequency, the error correction coefficients given in Table 6 show the magnitude of partial adjustment in one day. For instance, the error correction coefficient of 1-month swap rate and 1-month treasury bond yield, when the swap rate is the dependent variable and there is an exogenous intercept in the error correction model is -0.154. This means that 15.4% of a deviation from the equilibrium between 1-month swap rate and 1-month treasury bond yield will be corrected in one day. Moreover, the specification of this error correction model specification sets the 1-month swap rate as the variable that adjusts to restore the equilibrium. Figure 3 depicts the error correction coefficients calculated for each specification and tenures. In line with our discussion of the statistical significance of the cointegration relationship and the direction of the arbitrage

[12] Long-run equilibrium coefficients for tenures greater than 1 year are not depicted in Figure 2 since the cointegration tests indicate no significant long-run relationship between swap rates and treasury bonds in tenures greater than 1 year, the only exception being the cointegration at 2-year tenure when the treasury bond yield is the dependent variable and the specification includes an exogenous intercept.

mechanism, error correction coefficients are higher in short tenures and especially when the swap rate is the dependent variable. The coefficient becomes significantly small after 1 year so that the partial adjustment to equilibrium completely disappears.

5. Robustness Checks

In order to check the robustness of the results to the methodology employed we carry out EG and Johansen procedures apart from the PSS procedure. Results of the EG cointegration tests for different specifications and tenures are reported in Table 7 and results of the maximum eigenvalue tests and trace tests in the Johansen procedures for different specifications and tenures are reported in Table 8. Results of the EG and the Johansen procedures are strongly in line with the PSS results. Both procedures indicate that there exist long-run relationships between swap rates and treasury bond yields in shorter tenures. The relationships weaken at 9 months and disappear after 1 year. Thus, the robustness checks confirm our results.

Table 7. Engle-Granger Cointegration Test Results

Dependent	**Swap Rate**		**Treasury Bond Yield**	
Specification	No intercept in CE	Intercept in CE	No intercept in CE	Intercept in CE
1 month	-4.332***	-4.510***	-4.250***	-4.307***
2 months	-4.438***	-4.636***	-4.374***	-4.482***
3 months	-7.418***	-7.841***	-6.885***	-7.740***
6 months	-3.638***	-3.742**	-3.582***	-3.642**
9 months	-2.777*	-2.760	-2.717*	-2.612
1 year	-2.893*	-3.067	-2.856*	-2.900
2 year	-2.235	-2.759	-2.232	-2.613
3 year	-1.925	-2.598	-1.908	-2.330
4 year	-1.919	-2.647	-1.909	-2.301

Sample period: 06.08.2008 – 25.01.2012.
(*): significant at 10% level, (**): significant at 5% level, (***): significant at 1% level.

Table 8. Johansen Cointegration Test Results

	Trace Test			Max. Eigenvalue Test		
Specification	No intercept in CE and VAR	Intercept in CE and no intercept in VAR	Intercept in CE and VAR	No intercept in CE and VAR	Intercept in CE and no intercept in VAR	Intercept in CE and VAR
1 month	32.984***	38.113***	36.496***	29.503***	30.951***	30.589***
2 months	44.387***	51.563***	49.835***	40.065***	42.869***	42.691***
3 months	43.334***	50.473***	48.970***	39.787***	43.141***	42.906***
6 months	23.858***	27.590***	26.149***	21.490***	21.896***	21.207***
9 months	13.949**	16.739	15.068*	11.088*	11.772	10.766
1 year	14.593**	19.536*	17.489**	9.219	11.562	10.853
2 year	12.257*	17.230	14.509*	8.796	10.202	7.485
3 year	11.711*	15.964	12.901	8.109	9.377	6.597
4 year	10.431	13.674	10.736	7.182	7.983	5.844

Sample period: 06.08.2008 – 25.01.2012.
(*): significant at 10% level, (**): significant at 5% level, (***): significant at 1% level.

In addition, we split the sample into two parts at January 2010 and carry out the PSS procedure to check potential structural changes in the relationship between the swap and the bond markets which may stem from the European Sovereign Debt Crisis. The results of the PSS procedure for the split samples are reported in Table 9.

Similar to previous findings, the results in Table 9 indicate that swap rates and bond yields are cointegrated in both samples in shorter tenures but the cointegration disappears as the tenure increases. However, there are some structural changes in the relationship between cross currency swap and treasury bond markets as the European Sovereign Debt Crisis broke out. When swap rate is the dependent variable, error correction coefficients become smaller after January 2010, but the tenures in which the swap rates and treasury bond yields are cointegrated do not change. However, when treasury bond yield is specified as the dependent variable, cointegration at 3, 6 and 9-month tenures disappear after January 2010. These results indicate that prior to the European Sovereign Debt Crisis, treasury bond yields was also following swap rates but after January 2010, the relationship became more unidirectional. Moreover, in both cases, long-run equilibrium coefficients are close to 1 when the series are found to be cointegrated. In brief, the general pattern of the long-run relationship between the swap and bond markets is broadly in line with the previous findings when the structural changes are taken into account.

Table 9. PSS Cointegration Test Results for the Split Samples

	Sample: Aug 2008 - Dec 2009				Sample: Jan 2010 - Jan 2012			
	t-Stat	F-Stat	Error Correction Coefficient	Long Run Eq. Coefficient	t-Stat	F-Stat	Error Correction Coefficient	Long Run Eq. Coefficient
Tenure				**Dependent: Swap rate**				
1 month	-3.792***	8.257***	*-0.230*	1.068	-2.947**	4.763**	*-0.084*	1.118
2 months	-2.802**	6.778***	*-0.146*	1.118	-3.855***	7.630***	*-0.081*	1.146
3 months	-4.145***	10.521***	*-0.140*	1.115	-3.950***	7.975***	*-0.071*	1.159
6 months	-1.605	4.227**	*-0.045*	1.155	-3.106**	4.875**	*-0.036*	1.179
9 months	-0.555	2.183	*-0.009*	1.384	-2.220	2.475	*-0.018*	1.185
1 year	1.054	6.418***	*0.011*	0.933	-2.686**	3.611*	*-0.021*	1.177
2 years	0.853	2.741	*0.006*	0.983	-2.327*	2.811	*-0.014*	1.186
3 years	0.592	2.000	*0.004*	0.940	-1.940	2.154	*-0.011*	1.201
4 years	0.468	1.610	*0.003*	0.914	-1.854	2.129	*-0.010*	1.210
Tenure				**Dependent: Treasury bond yield**				
1 month	-2.597*	5.405**	*-0.038*	0.998	-3.652***	6.952***	*-0.073*	1.146
2 months	-3.536***	8.333***	*-0.042*	1.044	-2.875**	4.306**	*-0.041*	1.164
3 months	-5.032***	13.411***	*-0.079*	1.080	-1.760	1.619	*-0.020*	1.177
6 months	-3.746***	7.378***	*-0.072*	1.080	0.143	0.632	*0.001*	0.616
9 months	-2.643**	3.501*	*-0.041*	1.092	-1.101	0.935	*-0.006*	1.242
1 year	-1.763	1.674	*-0.019*	1.189	-0.908	0.732	*-0.005*	1.254
2 years	-0.860	0.548	*-0.010*	1.333	-0.338	0.262	*-0.002*	1.346
3 years	-0.788	0.558	*-0.008*	1.405	0.016	0.071	*0.000*	-1.391
4 years	-0.851	0.373	*-0.011*	1.312	-0.091	0.030	*-0.001*	1.420

(*): significant at 10% level, (**): significant at 5% level, (***): significant at 1% level.

6. Implications for Turkish Economy

The empirical results of the study have several implications for Turkish economy. The long-run equilibrium relationship between swap and bond markets in shorter tenures indicate that any deviations from the long run equilibrium will be corrected shortly. Therefore there will be no persistent arbitrage opportunity in these markets. Hence, the swap spreads will be stable. This result implies that these financial markets are liquid and efficient in Turkey. This also enhances the efficiency and flexibility of the asset liability management of the Turkish banks. As long as the swap spreads are stable, the risks associated with foreign currency borrowing decrease due to the fact that cross currency swaps enable the banks to convert foreign currency funds to Turkish lira and to invest in the Turkish lira assets such as loans and treasury bonds. The flexibility in the swap market provides cost advantage to the banks. This contributes to the well-functioning of the banking system and the credit markets.

The stability of the swap spread has important implications for monetary policy as well. If the swap and bond markets are closely related, the central bank can affect the swap rates as it affects the bond yields. This enables the central bank to control short term portfolio movements since one of the most active means of short term foreign investment in Turkey is currency swaps (Central Bank of Turkey, Inflation Report, April 2012).

7. Conclusion

This study attempts to test the swap-covered interest parity condition in Turkey by investigating the long-run equilibrium relation between TRY/USD cross currency swap and treasury bond markets employing the cointegration testing procedure suggested by Pesaran, Shin and Smith (2001). According to the cointegration test results and estimated cointegrating vectors, TRY/USD cross currency swap and treasury bond markets are closely related to each other especially in very short tenures but their dynamics significantly differ from each other in longer tenures. These results are quite sensible since the short term cross currency swaps and treasury bonds have almost the same cash flow and risk structures where the longer term ones have some important differences. Another important finding of the study is that the statistical significance of the cointegration is higher when the swap rate is specified as the dependent variable and the treasury bond yield is taken as the independent variable in the underlying error correction models. This implies that the direction of the arbitrage mechanism may be from treasury bond yields to swap rates and hence the deviations from equilibrium are usually arbitraged away by using swaps rather than bonds.

Estimates of the cointegrating vectors indicate that the equilibrium relationship between short term swap rates and treasury bond yields is roughly one-to-one as required by the covered interest parity condition. Furthermore, the error correction coefficients recovered from the cointegrating vectors are higher in short tenures but become significantly small after 1 year so that the deviations from the covered interest parity persist.

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