Assessing the Effects of a Policy Rate Shock on Market Interest Rates: Interest Rate Pass-Through with a FAVAR Model – The Case of Turkey for the Inflation-Targeting Period

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Abstract: The purpose of this paper is to investigate the effectiveness of the central bank's policy rate on market interest rates in Turkey for the inflation-targeting period. Empirical evidence suggests that (i) all interest rates respond to a positive policy rate shock positively for all periods and have a hump shape for government debt security yields as well as for domestic-currency– and foreign-currency–denominated time deposit interest rates; (ii) as maturities increase, the responses of all interest rates to the policy shock increase; (iii) the responses to the policy shock of credit interest rates with higher demand elasticity and longer maturity, such as vehicle and housing rates, is lower than those of others that we consider and (iv) the interest-rate responses of foreign-currency–denominated commercial credits are lower than those of domestic-currency–denominated commercial credits.

JEL Codes: E43, E52, E58, and E59.
Key Words: Interest Rate Pass-Through; Monetary Policy; and FAVAR.

I. Introduction

Central banks generally use their policy (short-term) interest rate as the principal tool to conduct monetary policy in order to affect economic performance through a transmission mechanism, such as longer-term interest rates, credit and asset price channels, etc. Commercial banks determine the loan and deposit interest rates and bond market participants determine the bond market interest rates for various maturities by considering the change in marginal costs of funds after central banks set the short-term interest rate. Interest rate pass-through, defined as the degree and speed of adjustment of retail rates to the policy rate under market rate stickiness, emerges in this process (De Bondt, 2005). Subsequently, the expenditure and investment decisions of households and firms – and eventually economic performance – are expected to be affected through the change in different market interest rates. Thereby, interest rate pass-through is crucial for the effectiveness of monetary policy. . If the degree of interest rate pass-through is complete and the adjustment speed is high, the transmission mechanisms of monetary policy will be enriched and thus contribute to price stability and financial stability. Thus, it is important to examine interest rate pass-through in terms of its effectiveness on monetary policy for economic performance.

There is substantial empirical research analyzing interest rate pass-through. Paisley (1994), Heffernan (1997), Hofmann and Mizen (2004), Becker et al. (2012) and Fuertes et al. (2010) for the United Kingdom, Payne and Waters (2008) for the United States, Mojon (2000), Sander and Kleimeier (2004), De Bondt (2005), DDenklemi buraya yazın.e Bondt et al. (2005) and Kleimeier and Sander (2006) for Euro-area countries and Borio and Fritz (1995) for a set of developed countries find a significant interest rate pass-through effect between the policy rate and retail rates. Some studies focus on developing countries. Egert et al. (2007) for five Central and Eastern European Countries, Humala (2005) for Argentina, Bredin et al. (2002) for Ireland, Burgstaller (2005) for Austria and Rocha (2012) for Portugal find statistically significant results for different market rates. All these results display that market rates respond to changes in policy interest rates, but there are few studies about interest rate pass-through for Turkey. Aydin (2007) reveals that interest rate pass-through is highest for housing loans and lowest for corporate loans and that the policy rate can be used to control credit-driven demand. Ozdemir (2009) finds complete interest rate pass-through in the long run and Yildirim (2012) analyses interest rate pass-through for cash, automobile, housing and corporate loan rates.

Our paper differs from previous studies in several aspects. Earlier studies on interest rate pass-through do not consider a large data set for when central banks set their interest rates. We, using the Factor-Augmented Vector Autoregressive (FAVAR) model employed by Bernanke, Boivin and Eliasz (2005), address this this problem. Further, our study is the first in the literature to use FAVAR to invesitigate the effectivenes of short-term interest rate on market rates. Thanks to this model, we can use a large number of variables without a multicollinearity problem. Thus, FAVAR allows us to assess the effects of monetary policy on economic activity with a large number of the economic time series considered by central banks. Especially for monetary policy analyses, FAVAR resolves the limited

information problem inherent in the standard small-scale vector autoregressive (VAR) model. Thus, FAVAR adresses VAR's omitted information problem, which is encountered while analysing monetary policy shocks, and provides a better measure for capturing the stance of monetary policy. Furthermore, although we can not obtain interest rate pass-through coefficients through the FAVAR model, the method allows us to elaborate the responses of various market rates to changes in short-term interest rate. Thus, we are able to assess which market rates are affected and over how many periods these effects remain. Owing to this feature, FAVAR dominates other linear econometric models. With FAVAR we can thus capture the effects of monetary policy on various interest rate indicators simultaneously, which comprise not only credits of different types, maturities and currencies but also deposit rates of different maturities and currencies. Also, short of these retail rates (credit and deposit interest rates), we use interest rate for government debt securities and treasury bill yields.

The purpose of this paper is to investigate the effectiveness of short-term interest rate on market interest rates in Turkey for the period between December 2001 and April 2014. We want to demonstrate how short-term interest rate affects the various market rates. These effects, emerging in the first stage of monetary policy transmission mechanisms, determine the healthiness or effectiveness of the interest rate transmission channel. Our contribution to the literature on interest rate pass-through is to elaborate the effectiveness of the short-term interest rate on retail rates and on the interest rate for government debt securities by using a large data set with the FAVAR model.

This paper is organized into five sections. In Section II, we explain the methodology. In Section III, we describe the data set. Section IV presents the empirical evidence. Section V concludes the paper.

II. Methodology: Factor-Augmented Vector Autoregressive Model (FAVAR)

During central banks' decision-making processes regarding their policy stances, they take into account a large number of real and financial variables to predict some variables in central banks' reaction function (see Kozicki, 2001). Focusing on unanticipated changes in monetary policy standards, the VAR approach, employed by Sims (1992) and Bernanke and Blinder (1992) to measure the effects of monetary policy, generally does not cover large data sets. In other words, there is an omitted information problem in VAR because it is a small-scale model based on a limited information set (Vargas-Silva, 2008; Soares, 2013). For this reason, the standard VAR approach is not an appropriate methodology for central banks to fully analyze the economy. Variables not included in the standard VAR may cause them to misassess the effects of shocks (Bernanke et al., 2005). Sims (1992) calls one of these misassessments the "price puzzle", which is inadequate or imperfect information about future inflation. The other problem arising from the standard VAR in monetary policy analyses concerns impulse-responses, which in VAR can only be observed through a small subset of variables. However, to assess the effects of monetary policy on economic activity it is necessary to examine the

responses of multiple indicators that capture policy change (Igan et al., 2013). The above-mentioned problems, called multicollinearity, can be addressed using the FAVAR model, which combines the standard VAR model with Stock and Watson's (1998) dynamic factor analysis to capture economic dynamics by extracting factors from a large data set. Using VAR to analyse monetary policy shock causes a loss of information and even an invalidity problem with the empirical results. Using FAVAR allows reducing large variable sets to only a few variables without loss of information and avoids the degrees-of-freedom problems inherent in the standard VAR model.

In this paper, we use the FAVAR methodology employed by Bernanke et al. (2005), who apply Stock and Watson's (1998; 2005) dynamic factor analyses. Let X_t equal the $N \times 1$ vector of the economic time series, which is stationary and has zero mean variables. N indicates the number of informational time series, which in this case is "large". Y_t is a vector of $M \times 1$ observable macroeconomic variables, which contains a subset of X_t. In this paper, Y_t represents policy rate, but it may not capture additional information, which in this case can be provided by the $K \times 1$ vector of the unobservable or latent factors, F_t. Representing a wide range of economic variables, F_t has most of the information contained in X_t. In the standard VAR approach, we cannot estimate F_t directly. Also here, K is "small". On the other hand, N is assumed to be much greater than the number of factors ($N \geq K+M$). Furthermore, $\Phi(L)$ denotes the appropriate lag of the polynomial of finite order d in the lag operator L. Φ_j ($j=1,...,d$) is the coefficient matrix. v_t is an error term that has a zero mean and a covariance matrix. In this framework, Bernanke et al. (2005) show that the joint dynamics of (F_t, Y_t) can be given by the following transition equation:

$$\begin{bmatrix} F_t \\ Y_t \end{bmatrix} = \Phi(L) \begin{bmatrix} F_{t-1} \\ Y_{t-1} \end{bmatrix} + v_t \tag{1}$$

Equation 1 is a standard VAR in (F_t, Y_t). However, if the $\Phi(L)$ terms that relate Y_t to F_{t-1} are not all zero matrix, Equation 1 is not reduced to a standard VAR in Y_t. In this case, Bernanke et al. (2005) describe Equation 1 using FAVAR. Thereby, estimating a system without F_t is a standard VAR, but Equation 1 contains not only observable but also omitted variables. In other words, since the factors in Equation 1 are unobserved, we can not directly estimate this standard VAR equation. Therefore, we can write Equation 2 to explain the dynamic factor model by assuming that the informational time series X_t is related to the unobservable factors F_t and the observable factors Y_t.

$$X_t' = \Lambda^f F_t' + \Lambda^y Y_t' + e_t' \tag{2}$$

Λ^f is an $N \times K$ matrix of factor loadings. Λ^y is an $N \times M$ and e_t is an $N \times 1$ vector of error terms. According to Equation 2, Y_t and F_t can be correlated, which drive the common dynamics of X_t. We can interpret

F_t as including arbitrary lags of the fundamental factors; otherwise, X_t depends only on the current and not the lagged values of the factors.

III. Data Description

We used monthly data for the period between December 2001 and April 2014. Data used in the FAVAR model are considered within two groups of variables: slow- and fast-moving. We consider real variables, prices, government budget variables and balance-of-payment indicators slow-moving variables, and they react to policy interest rate shocks. Our fast-moving variables, comprising financial indicators such as credits, deposits, interest rates, exchange rates, asset prices, risk premium indices and central bank balance sheet indicators, contemporaneously react to policy interest rate shocks. Our policy instrument is the interbank interest rate, which is determined as a proxy variable for the Central Bank of the Republic of Turkey's (CBRT) policy rate (similar to Clarida et al. 1998). Otherwise we use the US' two-year and 10-year Treasury constant maturity rate, a US two-year and 10-year credit default swap (CDS), the Federal Reserve (FED) policy interest rate and VIX indices as exogenous variables. We report a set of analyses including a three-month Turkish Treasury bill yield; a two-year Turkish Treasury bond yield; the interest rate for government debt securities; personal, vehicle, housing and consumer credit rates; TL- (domestic currency) and foreign-currency– (FX; USD and Euro) denominated commercial credit rates; TL- and FX-denominated interest rates for time deposits of up to one month, three months, one year and more than one year. The complete list of variables used in this paper and their data sources are provided in Table A1 in the Appendix.

All the variables used in the FAVAR analyses should be covariance stationary. Hence, we employ Augmented Dickey Fuller (henceforth ADF), Phillips-Perron (henceforth PP) and Elliot-Rothenberg-Stock (henceforth ERS) tests for unit root, and the Kwiatkowski-Phillips-Schmidt-Shin (henceforth KPSS) test for stationarity for all data except for all Turkish interest rates. We use the Im-Pesaran-Shin panel unit root test (henceforth IPS) for Turkish interest rates. We perform a panel test because test statistics for the Turkish interest rates are mixed, possibly because of the low power of the test due to the small sample (Campbell and Perron, 1991; Wu and Zhang, 1997). Since these variables are similar in nature, following Malliaropulos (2000) and Costantini and Lupi (2007), we choose to use a panel unit root test for interest rates and we reject the null of the unit root. The results of these time series and the panel unit root tests indicate that all data used in this paper are stationary; they are shown in Table A2 and Table A3 in the Appendix, respectively.

We also use the sequential modified LR Test Statistic, Final Prediction Error, the Akaike Information Criterion and the Hannan-Quinn Information Criterion. All these criteria suggest selecting two lags to estimate the FAVAR model. Moreover, we choose Alessi, Barigozzi and Capasso's (2010) determination method for the number of factors, and determine two unobserved factors . The test statistics for the number of factors are provided in Table A4 in the Appendix; we use these two factors to show a high share in the variation of the panel – in this case 0.89 percent using the

cumulative variance share. We also determine the number of burn in draws and the number of keeper draws: 50 and 100, respectively.

IV. Empirical Evidence

Figure 1 reports the impulse response functions of 22 interest rates for 24 periods when a one-standard deviation shock (0.906989) is given to the policy rate. The solid middle line in the figure indicates the median and the dotted lines indicate one-standard-deviation confidence bands. The results of the impulse responses are represented in Table 1. Similar to Bernanke et al. (2005), we gathered the confidence bands from Kilian's (1998) bootstrap procedure. It seems that all interest rates respond to a policy rate shock similarly and in a statistically significant fashion for the 24 periods. When we compare the impulse response patterns across interest rates, they look like a hump[1].

Figures 1.1, 1.2 and 1.3, respectively, show how the three-month Treasury bill yield, the two-year Treasury bond yield and the interest rate for government debt securities respond to a one-standard-deviation positive shock to the policy rate; that is, increasing the rates we consider. These responses peak in their third periods and persist for all periods. Also, as maturity increases, longer-term bonds have higher responses.

Figures 1.4 to 1.7, respectively, exhibit the responses of TL-denominated consumer credit rates and its subcategories, such as personal, vehicle and housing credit interest rates. As shown, a shock to the policy rate increases these interest rates and the responses of these interest rates peak in the third and fourth periods, and then persist for all periods. Furthermore, since the interest rate elasticities of vehicle and housing credits are expected to be high, the responses of these credits' interest rates are lower than the response of the personal credit rate, which has a shorter maturity than vehicle and housing credit interest rates. The responses of TL- and FX-denominated commercial credit interest rates are shown in Figures 1.8, 1.9 and 1.10. All the commercial credits interest rates increase as the policy rate increases until the fourth and fifth periods. When the policy rate increases, which may be expected to trigger capital inflows, the interest rate responses of TL-denominated commercial credits increase more than the interest rate responses of FX-denominated commercial credits. This result can be interpreted in the following manner: an increase in policy rate encourages firms to borrow with FX-denominated loans. Since interest rates for FX-denominated liabilities are lower than for TL-denominated liabilities, a shock to the policy rate feeds the liability dollarization more. Furthermore, since the elasticity of the TL-denominated commercial credit interest rate is expected to be higher than TL-denominated consumer credit rates, when we compare the responses of these two

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[1] All results of the impulse responses are similar to the 2006-2014 subsample. Otherwise, we employ the US interest rates, comprising the two-year and 10-year Treasury constant maturity rates and the FED policy rate as I(0) in the exogenous variable. Moreover, we try to remove the US interest rates from the exogenous variable. All of these results are robust. These analyses are not reported here but are available from the authors upon request.

rates, it seems that the response of the TL-denominated rate is lower than the response of the TL-denominated consumer credit rate.

The other figures indicate the TL- and FX-denominated time deposit interest rates. A shock to the policy rate increases all the time deposit interest rates. The responses of all TL-denominated time deposit interest rates to a policy rate shock are higher than the responses of all FX-denominated time deposit interest rates. Nevertheless, the effects of a shock are more persistent in USD-denominated time deposit interest rates compared to Euro-denominated time deposit interest rates. Therefore, when a one-standard-deviation shock is given to the policy rate, the effect on USD-denominated time deposit rates lasts longer than on Euro-denominated time deposit rates. Otherwise, while the responses of TL-denominated time deposit interest rates peak in the third and fourth periods, the responses of FX-denominated time deposit interest rates peak in the fifth and sixth periods, and the effects of the shock persist for all periods. For TL-denominated time deposit interest rates, the longer the maturity of these deposits, the higher the response to the policy rate. Similar to TL time deposit interest rates, the responses of FX time deposit interest rates increase when the maturities lengthen. This inclination resulted in the CBRT implementing a new monetary policy framework starting in October 2010, where it varied the reserve requirement ratios for different maturities of TL and FX time deposits. Thus, the CBRT aimed to encourage banks to borrow long term by decreasing reserve requirement ratios for longer-maturity TL and FX time deposits. However, because maturities' responses to a one-standard deviation shock to policy rate increases as TL- and FX-denominated time deposits lengthen, the CBRT's new reserve requirement policy may still be unsuccessful in balancing policy interest rate shocks.

V. Conclusion

In this paper, we investigate the interest rate pass-through from the policy rate to market interest rates such as credit rates, deposit rates and government debt securities in Turkey. We employ Bernanke et al.'s (2005) (2005) FAVAR methodology to assess how market interest rates are affected and how long these effects remain for the inflation-targeting period. Thus, we aimed to show that how policy rate affects market rates is important for monetary policy transmission mechanisms.

Our analyses suggest four main results about interest rate pass-through for Turkey.

First, the responses of all interest rates to a one-standard-deviation shock to policy rate show similar patterns and are statistically significant. When a shock is given to the policy rate, the responses of all interest rates that we consider increase, and peak around the third to sixth period. Furthermore, the effects of a shock on these interest rates persist for at least the 24 periods we consider.

Second, as maturities lengthen for interest rates for government debt securities, yields and TL- and FX-denominated time deposit rates, responses increase. Observing higher responses in longer maturity instruments may go against credible inflation targeting for central banks (see Berument and Froyen, 2009). Because central banks implement an inflation-targeting strategy to pursue price

stability, in determining a short-term policy rate, they primarily want to affect short-term market interest rates, and in this way, affect long-term market interest rates. Thereby, a shock to the policy rate increasing the responses of long-term market interest rates means that inflation expectations will increase in the future. This result may cause the CBRT to fail to attain its inflation targets or even encounter a credibility problem, which negatively affects not only price stability but also financial stability. On the other hand, the response of the two-year maturity interest rate is the highest of all rates we consider. This finding suggests that the conduct of monetary policy could decrease inflation expectations for longer than two years, but the data set that we employed did not let us observe this effect.

Third, credit rate responses to a shock that have higher demand elasticities and longer maturities, such as vehicle and housing credits, are lower than the responses of the personal credit rate that we consider. Fourth, the lower interest rate responses of FX-denominated commercial credits than TL-denominated commercial credits may encourage firms to borrow with FX currency and thus induce liability dollarization. Therefore, the CBRT should adjust its policy rate by smoothing to maintain the credibility of its monetary policy.

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Figure 1: Interest Rates Responses to Short-Term Policy Rate
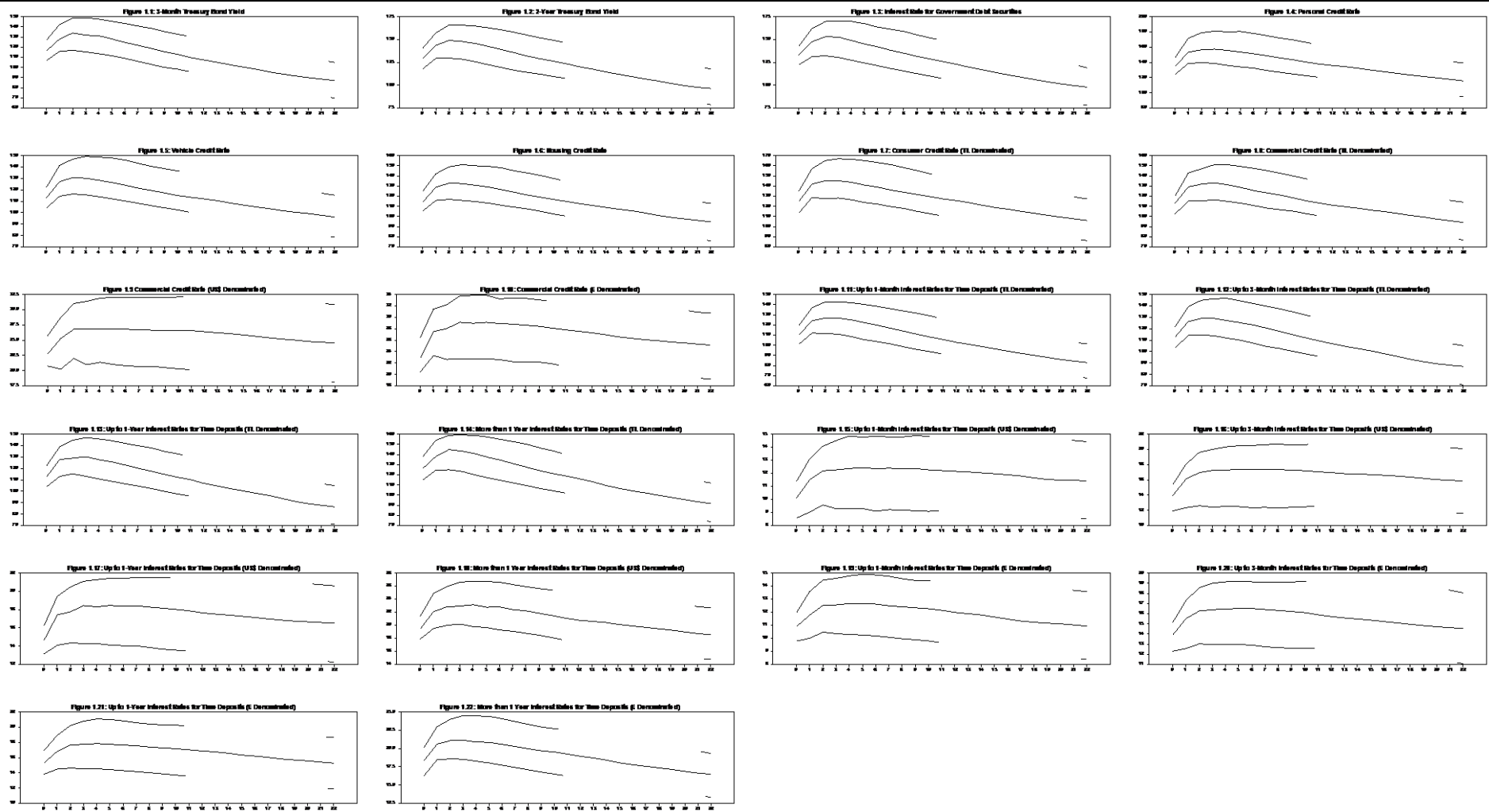
Note: The solid lines represent the impulse responses. The dashed lines report the upper and lower bands for the impulse responses.

Table 1: Results of Impulse Responses

#	3-Month Treasury Bill Yield Period Average	2-Year Government Bond Yield Period Average	Interest Rate for Government Debt Securities	Personal Credit Rate (TL Denominated)	Vehicle Credit Rate (TL Denominated)	Housing Credit Rate (TL Denominated)	Consumer Credit Rate (TL Denominated)
0	83.07	92.13	94.09	98.85	81.97	83.27	91.04
1	116.38	129.62	132.97	134.84	113.04	114.15	124.95
2	128.01	143.58	147.63	153.23	127.27	128.75	141.96
3	133.95	149.06	152.99	156.57	130.67	132.80	145.05
4	131.69	147.84	152.71	157.29	130.18	132.38	145.12
5	131.17	145.70	148.95	155.65	128.36	130.71	143.70
6	127.99	142.50	145.08	153.55	126.33	129.04	140.91
7	124.60	139.02	142.04	151.27	124.05	126.50	138.94
8	121.65	135.52	138.19	148.69	121.50	123.81	136.04
9	118.71	131.81	135.08	145.85	119.42	121.13	133.91
10	115.49	128.82	131.65	143.36	117.31	118.93	131.80
11	112.85	126.26	128.79	140.36	115.01	116.84	129.58
12	109.69	123.32	125.75	137.76	113.50	114.75	127.33
13	107.40	120.05	122.91	135.87	112.06	112.59	125.66
14	105.09	117.52	119.68	134.36	110.60	110.72	123.65
15	102.65	114.42	116.76	132.21	108.53	108.90	121.02
16	100.35	111.87	113.93	129.75	106.68	107.06	118.78
17	98.30	109.28	111.26	127.57	105.03	105.55	117.05
18	95.54	106.80	108.66	125.48	103.51	103.37	114.94
19	93.52	104.51	106.15	123.33	101.78	101.01	113.16
20	91.65	101.81	103.72	121.42	100.41	99.09	111.13
21	89.99	99.49	101.41	119.57	99.19	97.56	109.39
22	88.56	97.64	99.59	117.62	97.74	96.16	107.72
23	87.05	96.38	97.82	115.69	96.12	94.74	106.06

Table 1: Results of Impulse Responses (Cont.)

#	Commercial Credit Rate (TL Denominated)	Commercial Credit Rate (USD Denominated)	Commercial Credit Rate (EURO Denominated)	Up to 1-Month Interest Rates for Time Deposits (TL Denominated)	Up to 3-Month Interest Rates for Time Deposits (TL Denominated)	Up to 1-Year Interest Rates for Time Deposits (TL Denominated)	More than 1 Year Interest Rates for Time Deposits (TL Denominated)
0	82.52	16.23	17.40	79.36	80.74	81.21	88.88
1	113.17	22.76	22.92	110.21	112.86	112.55	126.14
2	129.07	25.29	27.50	124.11	126.26	127.82	138.09
3	131.85	26.79	28.04	126.67	129.08	129.00	144.88
4	133.15	26.79	29.13	126.76	128.94	130.18	143.26
5	131.21	26.81	28.95	124.94	127.11	127.62	140.74
6	128.65	26.80	29.12	122.29	125.20	125.71	137.14
7	125.49	26.80	28.91	119.60	123.19	122.95	134.23
8	123.28	26.70	28.79	116.68	120.44	120.14	130.61
9	121.07	26.64	28.61	113.89	117.57	117.53	127.28
10	118.41	26.66	28.43	110.86	114.66	114.86	123.93
11	115.42	26.62	28.10	108.10	111.94	112.29	121.05
12	113.21	26.57	27.82	105.68	109.33	110.24	118.60
13	111.06	26.39	27.56	102.89	106.83	106.97	115.95
14	109.64	26.22	27.30	100.85	104.52	104.71	113.04
15	108.09	26.07	26.96	98.67	102.53	102.35	109.43
16	106.19	25.85	26.58	96.34	100.55	100.34	106.62
17	104.81	25.62	26.32	94.10	98.02	98.25	104.22
18	102.97	25.38	26.08	91.96	95.71	96.33	102.10
19	100.98	25.17	25.91	89.97	93.15	93.71	99.93
20	99.44	25.01	25.67	87.95	91.07	91.08	97.74
21	97.38	24.78	25.52	85.90	89.34	89.09	95.53
22	95.75	24.67	25.32	84.41	88.04	87.72	93.44
23	94.10	24.52	25.13	82.96	87.05	86.36	91.66

Table 1: Results of Impulse Responses (Cont.)

#	Up-to-1-Month Interest Rates for Time Deposits (USD Denominated)	Up-to-3-Months Interest Rates for Time Deposits (USD Denominated)	Up-to-1-Year Interest Rates for Time Deposits (USD Denominated)	More than 1-Year Interest Rates for Time Deposits (USD Denominated)	Up-to-1-Month Interest Rates for Time Deposits (EURO Denominated)	Up-to-3-Months Interest Rates for Time Deposits (EURO Denominated)	Up-to-1-Year Interest Rates for Time Deposits (EURO Denominated)	More-than-1-Year Interest Rates for Time Deposits (EURO Denominated)
0	7.33	10.13	11.07	14.25	7.71	9.91	10.93	13.34
1	10.12	13.96	14.67	19.47	10.90	13.91	15.30	18.32
2	11.50	16.09	17.42	22.09	11.78	15.52	16.83	20.59
3	12.19	16.95	17.77	22.83	12.53	16.27	17.68	21.08
4	12.27	17.24	18.44	22.94	12.56	16.39	17.75	21.13
5	12.37	17.29	18.31	23.16	12.66	16.46	17.85	20.88
6	12.45	17.36	18.46	22.77	12.66	16.51	17.75	20.85
7	12.35	17.33	18.36	22.81	12.62	16.51	17.65	20.57
8	12.40	17.36	18.42	22.41	12.49	16.42	17.57	20.28
9	12.33	17.37	18.28	22.22	12.42	16.32	17.40	19.97
10	12.37	17.27	18.15	21.84	12.35	16.22	17.28	19.69
11	12.27	17.21	18.02	21.48	12.27	16.11	17.18	19.53
12	12.21	17.07	17.87	21.09	12.15	15.89	17.03	19.24
13	12.16	16.95	17.64	20.77	11.99	15.72	16.88	18.94
14	12.11	16.81	17.51	20.60	11.89	15.59	16.76	18.70
15	12.03	16.77	17.40	20.44	11.79	15.48	16.58	18.41
16	11.97	16.69	17.27	20.13	11.63	15.36	16.34	18.04
17	11.89	16.60	17.13	19.91	11.47	15.23	16.21	17.79
18	11.80	16.50	16.98	19.69	11.33	15.09	16.04	17.57
19	11.65	16.36	16.85	19.47	11.23	14.96	15.83	17.36
20	11.53	16.20	16.74	19.26	11.16	14.83	15.70	17.14
21	11.48	16.03	16.66	18.99	11.11	14.71	15.58	16.87
22	11.46	15.94	16.58	18.73	11.03	14.63	15.42	16.64
23	11.42	15.85	16.50	18.55	10.93	14.53	15.28	16.48

Note: All impulse responses different from zero are statistically significant.

APPENDIX

Table A1: Data and Sources

Variable Name	Source
Industrial Production Index	Central Bank of the Republic of Turkey
Industrial Production of Manufacturing	Central Bank of the Republic of Turkey
Mining and Quarrying	Central Bank of the Republic of Turkey
Mining of Coal and Lignite	Central Bank of the Republic of Turkey
Extraction of Crude Petroleum and Natural Gas	Central Bank of the Republic of Turkey
Mining of Metal Ores	Central Bank of the Republic of Turkey
Other Mining and Quarrying	Central Bank of the Republic of Turkey
Manufacture of Tobacco Products	Central Bank of the Republic of Turkey
Manufacture of Textiles	Central Bank of the Republic of Turkey
Manufacture of Wearing Apparel	Central Bank of the Republic of Turkey
Manufacture of Leather and Related Products	Central Bank of the Republic of Turkey
Manufacture of Wood Products	Central Bank of the Republic of Turkey
Manufacture of Paper and Paper Products	Central Bank of the Republic of Turkey
Printing and Reproduction of Recorded Media	Central Bank of the Republic of Turkey
Manufacture of Coke and Petroleum Products	Central Bank of the Republic of Turkey
Manufacture of Chemical and Chemical Products	Central Bank of the Republic of Turkey
Manufacture of Rubber and Plastic Products	Central Bank of the Republic of Turkey
Manufacture of Other Nonmetallic Mineral Products	Central Bank of the Republic of Turkey
Manufacture of Basic Metals	Central Bank of the Republic of Turkey
Manufacture of Fabricated Metal Products	Central Bank of the Republic of Turkey
Manufacture of Machinery and Equipment	Central Bank of the Republic of Turkey
Manufacture of Computer Electronic and Optical Products	Central Bank of the Republic of Turkey
Manufacture of Electrical Products	Central Bank of the Republic of Turkey
Manufacture of Motor Vehicles and Trailers	Central Bank of the Republic of Turkey
Manufacture of Other Transport Equipments	Central Bank of the Republic of Turkey
Manufacture of Furniture	Central Bank of the Republic of Turkey
Electricity Gas Stream and Air Conditioning Supply	Central Bank of the Republic of Turkey
Capacity Utilization Rate of Manufacturing Industry	Central Bank of the Republic of Turkey
Vehicle Production	Central Bank of the Republic of Turkey
Unemployment Rate	Central Bank of the Republic of Turkey
Consumer Price Index	Central Bank of the Republic of Turkey
Producer Price Index	Central Bank of the Republic of Turkey
Firm Confidence Index	Central Bank of the Republic of Turkey
USD Exchange Rate	Central Bank of the Republic of Turkey
Euro Exchange Rate	Central Bank of the Republic of Turkey
Exchange Rate Basket	Central Bank of the Republic of Turkey
Real Effective Exchange Rate	Central Bank of the Republic of Turkey
Export	Central Bank of the Republic of Turkey
Import	Central Bank of the Republic of Turkey
Current Account Deficit	Central Bank of the Republic of Turkey
Capital and Financial Account	Central Bank of the Republic of Turkey
Unregistered Capital Inflows	Central Bank of the Republic of Turkey
International Reserves	Central Bank of the Republic of Turkey

Table A1: Data and Sources (Cont.)

Variable Name	Source
General Budget Balance	Central Bank of the Republic of Turkey
General Budget Primary Balance	Central Bank of the Republic of Turkey
General Budget Cash Balance	Central Bank of the Republic of Turkey
General Budget Net Borrowing	Central Bank of the Republic of Turkey
General Budget Net Foreign Borrowing	Central Bank of the Republic of Turkey
General Budget Net Domestic Borrowing	Central Bank of the Republic of Turkey
Time Deposit	Central Bank of the Republic of Turkey
Demand Deposit	Central Bank of the Republic of Turkey
Foreign Exchange Deposit	Central Bank of the Republic of Turkey
Consumer Credits	Central Bank of the Republic of Turkey
Credits to Private Sector	Central Bank of the Republic of Turkey
Securities of Banking Sector	Central Bank of the Republic of Turkey
Currency	Central Bank of the Republic of Turkey
Reserve Money	Central Bank of the Republic of Turkey
Reserve Requirements	Central Bank of the Republic of Turkey
Deposits of Banking Sector in CBRT	Central Bank of the Republic of Turkey
Assets of CBRT	Central Bank of the Republic of Turkey
Monetary Base	Central Bank of the Republic of Turkey
M1 Money Stock	Central Bank of the Republic of Turkey
M2 Money Stock	Central Bank of the Republic of Turkey
M3 Money Stock	Central Bank of the Republic of Turkey
Interest Rate for Government Debt Securities	Republic of Turkey, Ministry of Development
Turkey 3-Month Treasury Bill Yield Average	Global Financial Data
Turkey 3-Month Treasury Bill Yield Close	Global Financial Data
Turkey 2-Year Treasury Bond Yield Average	Global Financial Data
Turkey 2-Year Treasury Bond Yield Close	Global Financial Data
Central Bank Policy Rate	Central Bank of the Republic of Turkey
CBRT Borrowing Rate (Average)	Global Financial Data
CBRT Lending Rate (Average)	Global Financial Data
Rediscount Rate	Central Bank of the Republic of Turkey
Overnight Interbank Rate (Average)	Thomson Reuters Data Stream
Overnight Interbank Rate (Close)	Thomson Reuters Data Stream
Overnight Interbank Rate (Maximum)	Thomson Reuters Data Stream
Overnight Interbank Rate (Minimum)	Thomson Reuters Data Stream
Overnight Interbank Lending Rate	Thomson Reuters Data Stream
Deposit Rates Period Average	Thomson Reuters Data Stream
Turkey 1-month Time Deposits Period Average	Global Financial Data
Turkey Depos 3 Months - Middle Rate	Thomson Reuters Data Stream
Total Weighted Average Interest Rate Applied to Deposits Opened by Banks (Deposits on TL)	Central Bank of the Republic of Turkey
Total Weighted Average Interest Rate Applied to Deposits Opened by Banks (Deposits on USD)	Central Bank of the Republic of Turkey
Total Weighted Average Interest Rate Applied to Deposits Opened by Banks (Deposits on €)	Central Bank of the Republic of Turkey
Up-to-1-Month Interest Rates for Time Deposits (TL Denominated)	Central Bank of the Republic of Turkey

Table A1: Data and Sources (Cont.)

Variable Name	Source
Up-to-3-Month Interest Rates for Time Deposits (TL Denominated)	Central Bank of the Republic of Turkey
Up-to-6-Month Interest Rates for Time Deposits (TL Denominated)	Central Bank of the Republic of Turkey
Up-to-1-Year Interest Rates for Time Deposits (TL Denominated)	Central Bank of the Republic of Turkey
More-than-1-Year Interest Rates for Time Deposits (TL Denominated)	Central Bank of the Republic of Turkey
Up-to-1-Month Interest Rates for Time Deposits (US$ Denominated)	Central Bank of the Republic of Turkey
Up-to-3-Month Interest Rates for Time Deposits (US$ Denominated)	Central Bank of the Republic of Turkey
Up-to-6-Month Interest Rates for Time Deposits (US$ Denominated)	Central Bank of the Republic of Turkey
Up-to-1-Year Interest Rates for Time Deposits (US$ Denominated)	Central Bank of the Republic of Turkey
More-than-1-Year Interest Rates for Time Deposits (US$ Denominated)	Central Bank of the Republic of Turkey
Up-to-1-Month Interest Rates for Time Deposits (€ Denominated)	Central Bank of the Republic of Turkey
Up-to-3-Month Interest Rates for Time Deposits (€ Denominated)	Central Bank of the Republic of Turkey
Up-to-6-Month Interest Rates for Time Deposits (€ Denominated)	Central Bank of the Republic of Turkey
Up-to-1-Year Interest Rates for Time Deposits (€ Denominated)	Central Bank of the Republic of Turkey
More-than-1-Year Interest Rates for Time Deposits (€ Denominated)	Central Bank of the Republic of Turkey
IS Bank Overnight Deposit Rate	Thomson Reuters Data Stream
AKBANK Overnight Deposit Rate	Thomson Reuters Data Stream
Yapi Kredi Bank Overnight Deposit Rate	Thomson Reuters Data Stream
Garanti Bank Overnight Deposit Rate	Thomson Reuters Data Stream
Vakif Bank Overnight Deposit Rate	Thomson Reuters Data Stream
Seker Bank Overnight Deposit Rate	Thomson Reuters Data Stream
City Bank Overnight Deposit Rate	Thomson Reuters Data Stream
Finans Bank Overnight Deposit Rate	Thomson Reuters Data Stream
Personal Credit Rate (TL Denominated)	Central Bank of the Republic of Turkey
Vehicle Credit Rate (TL Denominated)	Central Bank of the Republic of Turkey
Housing Credit Rate (TL Denominated)	Central Bank of the Republic of Turkey
Consumer Credit Rate (TL Denominated)	Central Bank of the Republic of Turkey
Commercial Credit Rate (TL Denominated)	Central Bank of the Republic of Turkey
Commercial Credit Rate (US$ Denominated)	Central Bank of the Republic of Turkey
Commercial Credit Rate (€ Denominated)	Central Bank of the Republic of Turkey
Istanbul Stock Exchange 100	Central Bank of the Republic of Turkey
Morgan Stanley Capital International	Thomson Reuters Data Stream
Emerging Market Bond Index Plus (Turkey)	Thomson Reuters Data Stream
US 2-Year Treasury Constant Maturity Rate	Thomson Reuters Data Stream
US 10-Year Treasury Constant Maturity Rate	Thomson Reuters Data Stream
US 2-Year Credit Default Swap	Bloomberg
US 5-Year Credit Default Swap	Bloomberg
FED Policy Rate	Thomson Reuters Data Stream
VIX	Chicago Board Options Exchange

Table A2: Unit Root Tests and Analyses of Time Series' Degree of Integration

Variable Name	# of Lags	ADF	PP	ERS	KPSS	Decision	Treatment	Slow/Fast
Industrial Production Index	12	-3.790**	-29.302**	-1.405	0.150	0	4	S
Industrial Production of Manufacturing	12	-3.565**	-26.536**	-1.371	0.128	0	4	S
Mining and Quarrying	11	-5.627**	-27.365**	-5.584**	0.156	0	4	S
Mining of Coal and Lignite	0	-14.352**	-14.452**	-14.371**	0.020	0	4	S
Extraction of Crude Petroleum and Natural Gas	11	-3.798**	-38.976**	-1.233	0.101	0	4	S
Mining of Metal Ores	11	-5.410**	-12.313**	-5.379**	0.129	0	4	S
Other Mining and Quarrying	11	-5.876**	-20.436**	-4.944**	0.145	0	4	S
Manufacture of Tobacco Products	6	-10.315**	-18.122**	-7.563**	0.025	0	4	S
Manufacture of Textiles	12	-2.831	-26.081**	-2.352	0.093	0	4	S
Manufacture of Wearing Apparel	4	-9.196**	-24.834**	-7.620**	0.032	0	4	S
Manufacture of Leather and Related Products	4	-10.275**	-21.718**	-10.288**	0.019	0	4	S
Manufacture of Wood Products	11	-5.438**	-27.441**	-4.590**	0.110	0	4	S
Manufacture of Paper and Paper Products	11	-5.223**	-39.638**	-2.728	0.148	0	4	S
Printing and Reproduction of Recorded Media	1	-14.391**	-22.073**	-14.440**	0.067	0	4	S
Manufacture of Coke and Petroleum Products	0	-13.412**	-13.505**	-13.190**	0.011	0	4	S
Manufacture of Chemical and Chemical Products	11	-3.582**	-23.419**	-3.430**	0.143	0	4	S
Manufacture of Rubber and Plastic Products	12	-2.794**	-32.143**	-1.520	0.100	0	4	S
Manufacture of Other Nonmetallic Mineral Products	13	-2.525	-19.289**	-1.203	0.261	0	4	S
Manufacture of Basic Metals	0	-19.240**	-19.373**	-18.946**	0.060	0	4	S
Manufacture of Fabricated Metal Products	11	-3.426*	-23.435**	-2.449	0.143	0	4	S
Manufacture of Machinery and Equipment	12	-2.151	-22.937**	-1.868	0.180	0	4	S
Manufacture of Computer Electronic and Optical Products	12	-2.981*	-27.613**	-1.219	0.254	0	4	S
Manufacture of Electrical Products	1	-15.743**	-24.056**	-14.292**	0.017	0	4	S
Manufacture of Motor Vehicles and Trailers	11	-3.439*	-25.838**	-3.092*	0.308	0	4	S
Manufacture of Other Transport Equipments	1	-18.112**	-24.400**	-18.167**	0.014	0	4	S
Manufacture of Furniture	12	-3.239*	-27.509**	-2.848*	0.163	0	4	S
Electricity Gas Stream and Air Conditioning Supply	11	-3.516**	-36.746**	-0.771	0.143	0	4	S
Capacity Utilization Rate of Manufacturing Industry	12	-2.613	-2.742	-2.607	0.410	1	2	S

Table A2: Unit Root Tests and Analyses of Time Series' Degree of Integration (Cont.)

Variable	# of Lags	ADF	PP	ERS	KPSS	Decision	Treatment	Slow/Fast
Vehicle Production	11	-3.725**	-32.363**	-2.611	0.370	0	4	S
Unemployment Rate	6	-1.600	-2.182	-1.607	0.216	1	4	S
Consumer Price Index	0	-9.159**	-9.222**	-7.992**	1.135**	0	4	S
Producer Price Index	0	-7.281**	-7.332**	-7.081**	0.862**	0	4	S
Firm Confidence Index	0	-7.907**	-7.962**	-7.808**	0.049	0	4	S
USD Exchange Rate	1	-8.719**	-8.933**	-8.705**	0.172	0	4	F
Euro Exchange Rate	0	-8.897**	-8.959**	-8.770**	0.078	0	4	F
Exchange Rate Basket	1	-8.803**	-9.005**	-8.548**	0.094	0	4	F
Real Effective Exchange Rate	1	-9.009**	-9.258**	-8.243**	0.165	0	4	F
Export	1	-13.755**	-20.530**	-13.626**	0.067	0	4	S
Import	11	-3.357*	-19.595**	-2.637	0.305	0	4	S
Current Account Deficit / GDP	13	-2.753	-5.529**	-2.335	0.597*	1	2	S
Capital And Financial Account / GDP	0	-7.624**	-7.676**	-7.630**	0.857**	0	1	S
Unregistered Capital Inflows / GDP	0	-10.521**	-10.594**	-10.553**	0.079	0	1	S
International Reserves	0	-12.127**	-12.211**	-12.097**	0.444	0	4	S
General Budget Balance / GDP	12	-6.207**	-3.573**	-1.946	0.810**	1	2	S
General Budget Primary Balance	11	-1.002	-14.086**	-0.976	0.907**	1	2	S
General Budget Cash Balance	11	-2.091	-12.261**	-1.159	0.644*	1	2	S
General Budget Net Borrowing	4	-2.525	-8.050**	-2.304	1.316**	1	2	S
General Budget Net Foreign Borrowing	1	-18.798**	-12.183**	-18.555**	0.302	0	1	S
General Budget Net Domestic Borrowing	5	-2.377	-11.675**	-2.281	0.830**	1	2	S
Time Deposit	3	-6.429**	-13.766**	-4.259**	0.103	0	4	F
Demand Deposit	1	-13.920**	-22.061**	-13.719**	0.027	0	4	F
Foreign Exchange Deposit	0	-11.501**	-11.581**	-10.548**	0.211	0	4	F
Consumer Credits	0	-6.442**	-6.487**	-6.156**	2.133**	0	4	F
Credits to Private Sector	5	-4.517**	-10.936**	-2.828*	0.198	0	4	F
Securities of Banking Sector	0	-10.481**	-10.553**	-10.501**	1.151**	0	4	F
Currency	0	-19.530**	-19.665**	-18.999**	0.136	0	4	F

Table A2: Unit Root Tests and Analyses of Time Series' Degree of Integration (Cont.)

Variable	# of Lags	ADF	PP	ERS	KPSS	Decision	Treatment	Slow/Fast
Reserve Money	6	-6.027**	-15.659**	-6.050**	0.045	0	4	F
Reserve Requirements	0	-13.270**	-13.362**	-13.029**	0.667*	0	4	F
Deposits of Banking Sector in CBRT, Turkey	1	-13.956**	-17.915**	-12.475**	0.115	0	4	F
Assets of CBRT	0	-11.400**	-11.479**	-10.533**	0.197	0	4	F
Monetary Base	4	-9.600**	-17.198**	-9.540**	0.040	0	4	F
M1 Money Stock	0	-15.158**	-15.263**	-14.437**	0.191	0	4	F
M2 Money Stock	0	-10.605**	-10.679**	-10.375**	1.304**	0	4	F
M3 Money Stock	0	-11.026**	-11.102**	-10.828**	1.408**	0	4	F
Istanbul Stock Exchange 100	0	-10.008**	-10.077**	-10.016**	0.146	0	4	F
Morgan Stanley Capital International	0	-2.169	-12.349**	-12.093**	0.093	0	4	F
Emerging Market Bond Index Plus (Turkey)	0	-12.930**	-12.201**	-12.151**	0.073	0	4	F
US 2-Year Treasury Constant Maturity Rate	1	-0.946	-0.735	-0.993	3.926**	1	2	F
US 10-Year Treasury Constant Maturity Rate	0	-1.655	-1.667	-1.657	10.465**	1	2	F
US 2-Year Credit Default Swap	0	-9.598**	-9.664**	-9.618**	0.122	0	4	F
US 5-Year Credit Default Swap	0	-9.387**	-9.452**	-9.409**	0.116	0	4	F
FED Policy Rate	9	-2.654	-1.097	-2.667	0.548*	1	2	F
VIX	0	-8.938**	-13.746**	-13.232**	0.031	0	4	F

Note: The number of lags is chosen using the Schwarz Information Criterion. "Decision" indicates the level of integration based on the results of the unit root tests. "Treatment" indicates how the series are transformed before using the estimate, with 1 = level; 2 = difference in level; 4 = log level difference. S = slow- and F = fast-moving variable.

Table A3: Im-Pesaran-Shin Panel Unit Root Test for Turkish Interest Rates

Number of Variables		Period
48		148
	Statistic	**Significant Level**
Z t̄	-17.797191	0.0000
Z t̄̄	-17.797014	0.0000
T̄	-3.680841	
T̄̄	-3.443584	
1% CV	-1.81	
5% CV	-1.73	
10% CV	-1.69	
Observation	**Mean**	**Std. Error**
7301	14.818	14.153

Table A4: Determination of Number of Factors

# of Factors	ICP1	ICP2
1	10.73633	10.73633
2	**10.04059***	**10.04059***
3	13.09043	14.5807
4	12.26118	13.75145
5	11.39725	12.88752
6	14.783	17.76354
7	14.29645	17.277
8	17.7693	22.24012
9	16.91113	21.38194
10	**13.49665***	17.96747
11	17.16818	23.12927
12	16.9307	22.89179
13	20.83285	28.28421
14	20.64977	28.10113
15	20.52862	27.97997
16	24.56139	33.50302
17	24.43048	33.37211
18	24.3252	33.26683
19	28.38972	38.82162
20	28.30591	38.73781

Note: * shows unobserved factors using Alessi, Barigozzi and Capasso's method (2010).