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A COINTEGRATION ANALYSIS OF ALTERNATIVE CORE INFLATION MEASURES FOR TURKEY

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A Cointegration Analysis of Alternative Core Inflation Measures for Turkey*

by

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Abstract

First off, we conduct a cointegration analysis for alternative core inflation measures offered by Cihan and Malatyalı (1999) on total inflation of Turkey. We observe that while some measures display the desired properties some do not. However, all those series display strong common deterministic trend. Additionally, we have tested the alternative measures of core inflation against the money growth.

1. Introduction:

The notion of the core inflation is evaluated as an important tool for the monetary policy makers. Even though this has been accepted by the many, the measurement of the core inflation displays a great variety, thus bringing controversy to the issue. Nevertheless, the main approach to the problem is examined as a decomposition problem (Shiratsuka, 1997). This decomposition approach mainly initiates from the idea of an underlying inflation, which can not be observed by the original price indices. Thus, the essence of this methodology motivates some follow up analyses. One of the main questions to be asked for any core inflation measure should be

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the testing for the long run relation between the original series and the proposed core inflation series. Thus we believe that, any sort of a *derived* core inflation measure should be cointegrated with the original series. This has been suggested by Freeman (1998), as a correction to Bryan and Cecchetti (1993). Bryan and Cecchetti have tested the relation between the total inflation and the alternative core inflation measures by employing simple regression, rather than using cointegration analysis whilst dealing with the non-stationary data.

Hence, in the first part of this study, we analyzed the consistency of alternative core inflation measures constructed for Turkey by Cihan and Malatyalı (1999) from this point of view.

In the second part of the paper, we have tested the alternative core inflation measures along with money growth. Thus, apart from an *internal* consistency, -by which we mean consistency within the total inflation and derived inflations- we check for the consistency of these measures with the money growth, where the hypothesis of money-induced inflation concept is tested.

2. Testing of the Alternative Core Inflation Measures

2.1. Consistency Tests for Core Inflation Measures

Cihan and Malatyalı (1999) [CM from now on], used the Turkish Consumer Price Index (CPI) data to obtain several alternative core inflation measures utilizing "Limited Influence Estimation"[1]. Basically, they have calculated five new indices. Two series are obtained by the "trimmed-mean approach" (CPITM, and CPTM12). CPITM is calculated by using monthly price changes and CPITM12 is calculated over yearly price changes. Two other series calculated be using "weighted-median approach". CPIWM and CPIWM12 series are constructed by using monthly price changes and 12 monthly price changes, respectively. A final series is calculated by extracting the *food* and *energy* sub-groups from the CPI, which is CPILFE.

All those estimates of the core inflation are originally employing a dissaggregation process that limits the original series according to a specific theoretical framework. Nevertheless, all of these methodologies sort out the original series and compute a new index which is simply a subset of the total price series, regardless of the process. These methods are essentially carried out to calculate the core inflation without using any sort of mechanical filtering such as Hodrick-Prescott Filter, but still aiming to decompose the total inflation series in to a transitory and a permanent components, in a way. Thus, this result brings out the question of cointegration between the total inflation and the core inflation -where, many also defines this notion by using the "*underlying inflation*" concept. Thus for any period the total inflation can be decomposed in to core and to its transient components as follows:

$$\pi_t = \pi_t^C + \pi_t^T \qquad (1)$$

Transient component is expected not to have the characteristics of the disturbances; and it should have a zero mean and a finite variance. Hence, the stationarity level of core inflation is expected to be same as the total inflation meaning there should exist a cointegration vector between those two series. Therefore, we have conducted several Augmented Dickey-Fuller (ADF) tests to identify the stationarity of the total inflation and alternative core inflation series. For the ADF tests we have used the logarithmic levels (the letter "L" indicates logarithmic levels) of the mentioned variables. Results of these tests are given in Table.1. As we can see in the table , all series (LCPI, LCPITM, LCPIWM, LCPILFE) are non-stationary. Therefore, another series of ADF tests are applied to the first difference of the series and concluded that all of those variables are I(1).

It must be noted that series calculated by yearly price changes are not considered. This is mainly due to lack of observation. Thus this generates major statistical problems when dealing with Vector Error

[1] see for example Wayne, M. (1999)

Correction analysis. Hence, the study is limited with three core inflation measures: CPILFE, CPITM and CPIWM.

Table.1

(Augmented) Dickey-Fuller Tests of Inflation,
Sample : 1994:06 –1999:10

	LCPI	**LCPILFE**	**LCPITM**	**LCPIWM**
ADF-Test(*)	-2.2616	-2.2994	-1.5219	-2.9253
% 5 C.V.	-3.4790	-3.4790	-3.4790	-3.4790

(*) All ADF tests include a trend, an intercept term and lagged difference of 1

	DLCPI	**DLCPILFE**	**DLCPITM**	**DLCPIWM**
ADF-Test(*)	-6.6442	-7.3134	-7.4009	-6.0352
% 5 C.V.	-2.9062	-2.9062	-2.9062	-2.9062

(*) ADF tests for DLCPI and DLCPIWM include an intercept term and lagged difference of 1, and for DLCPILFE and DLCPITM test include an intercept.

While conducting ADF tests for the level of individual series, a trend is included in to the test equation as the presence of a strong deterministic trend is observed in all series. This is one of the major properties of the Turkish price indices. Hence, apart from the deterministic trend, the search for a cointegration relation becomes more important as it is already measurable, that a "core" inflation measure should bring more than this common part.

As Table 1 shows, all the variables are integrated at the same order. Consequently, we have tested the cointegration relation of the alternative core inflation measures with the total inflation pair-wise.

For all individual tests, Akaike Information Criteria, Schwarz Criteria, and Likelihood Ratio Tests are used to determine the appropriate lag lengths for each cointegration tests. Table 2 reports those cointegration tests and the appropriate lag lengths.

Table.2

Johansen Cointegration tests of alternative core inflations and CPI

	LCPILFE	**LCPITM**	**LCPIWM**
Hypothesis of "No cointegration vector"			
Eigenvalue	0.05	0.20	0.19
Likelihood Ratio	5.96	14.94	18.42
% 5 C.V.	15.41	15.41	25.32
Hypothesis of "1 cointegration vector"			
Eigenvalue	0.04	0.004	0.07
Likelihood Ratio	2.40	0.27	4.69
% 5 C.V.	3.76	3.76	12.25
Lag Length	5	5	3

As seen in Table 2 we reject the hypothesis of a cointegration relation between the total inflation (CPI) and total inflation less food and energy (CPILFE).

Coming to another core inflation measure which is CPI-weighted median (CPIWM), the theoretical expectations towards this test are as follows: CPIWM is mainly constitutes of food, rent, energy and clothing sub-groups. Naturally, CPIWM is seen as a complementary sub-group for CPILFE. Therefore, we intuitionally expect that there should not be a cointegration relation between CPIWM and CPI series. Results of the cointegration tests for those two series also supports these expectations. In Table.2, the hypothesis of no cointegration is not rejected, so we conclude there is no cointegration between the series CPIWM and CPI.

The other calculated alternative measure was the series calculated using *Trimmed Mean* approach (CPITM). In this methodology, the basic idea is to cut out the *tails* of the distribution of the price index to reach a smoother indicator. According to the Johansen test results shown in Table 2, CPI and CPITM are not cointegrated at 5 % significance level, as well. Even though we have rejected that the presence of any cointegration

vectors between CPI and core inflation measures, we have observed that the rejection of the hypothesis of a cointegration vector between those two variables can be reversed at a confidence level of 10 %. That is, there exists respective cointegration vectors for CPITM and for CPIWM with CPI with looser confidence interval (about 10% level). Especially, CPITM tends to have a cointegration relation with CPI around 6% significance level. Thus, this questionable situation might be caused by the restricted sample period, meaning that we expect to identify a statistically significant cointegration relation between those two series with a larger sample period.

Table 3.

Normalized Cointegration Coefficients:		
LCPI	LCPITM	C
1.000000	-1.222447	1.026005
	(0.00554)	
	(-220.680)	
Error Correction:	**D(LCPI)**	**D(LCPITM)**
Adjustment Coef.	-0.335055	-0.065417
	(0.12198)	(0.10841)
	(-2.74678)	*(-0.60340)*

After obtaining the cointegration vector, the proceeding step is to estimate a Vector Error-Correction Model (VECM). The estimated speed of adjustment coefficients from the VECM model is shown at the lower part of the Table 3. The speed of adjustment coefficient indicates that LCPITM adjusts to shocks to LCPI almost at 3 periods. As CPI is not a money induced inflation theoretically, we expect this coefficient to be different than 1. As we expect, the cointegration coefficient of LCPITM is significantly different than 1.

2.2. Testing Alternative Measures Against Monetary Growth

In this section rather than testing the alternative core inflation measures calculated by CM against total inflation series, we conduct

similar test against monetary growth. Thus, as Bryan and Cecchetti indicates *"…..when people use the term core inflation they seem to have in mind the long-run, or persistent component of the measured price index, which is tied in some way to money growth"*[2]. Thus, in this analysis we have used money supply (M2Y). Additionally, we have included the Private Manufacturing Sector Price Index (PMP) disseminated by S.I.S. as a sub-group of Wholesale Price Index, as well. The main purpose for this decision is that this index have long been used as a proxy for core inflation by many researchers.

The stationarity test results for M2Y, and PMP are as follows:

Table.4

(Augmented) Dickey-Fuller Tests of Money and Private Manufacturing Price
Sample Range: 1987.01 1999.10 [3]

	LM2Y	**LPMP**
ADF-Test(*)	-2.1278	-1.7761
% 5 C.V.	-3.4399	-3.4399

(*) All ADF tests include a trend, an intercept term and lagged difference of 1.

	DLM2Y	**DLPMP**
DF-Test	-13.9564	-7.7386
% 5 C.V.	-2.8805	-2.8805

As seen from the above table, both series are integrated at the same order, [I(1)]. From the previous section we know that CPI and alternative core inflation series are also integrated at the same order. So proceeding with the cointegration tests yields the following results.

[2] Bryan, M.F. and Cecchetti, S.G., (1993)
[3] Note that these ADF tests were applied for a sample range of 1987.01 -1999.10. Nevertheless, the results of these tests for these variables also holds for 1994.01-1999.10 sample range.

Table 5.a

Johansen Cointegration tests of M2Y against CPI and PMP

	LCPI	**LPMP**
Hypothesis of "No cointegration vector"		
Eigenvalue	0.14	0.11
Likelihood Ratio	10.33	19.97
% 5 C.V.	15.41	15.41
Hypothesis of "1 cointegration vector"		
Eigenvalue	8.09×10^{-7}	0.01
Likelihood Ratio	5.18×10^{-5}	1.63
% 5 C.V.	3.76	3.76
Lag Length	5	2

Table 5.b

Normalized Cointegration Coefficients:		
LM2Y	LPMP(-1)	C
1.0000	-1.2912	-7.8855
	(0.04023)	
	(-32.0989)	
Error Correction:	**D(LM2Y)**	**D(LPMP)**
Adjustment Coef.	-0.05104	-0.0019
	(0.01243)	(0.00947)
	(-4.10424)	*(0.21090)*

From Table 5.a we see that LM2Y is not cointegrated with LCPI. Thus this result meets our theoretical expectation. Basically, this is the evidence of the need for an alternative inflation concept, then called the "core inflation". To be more explicit, CPI does not meet the definition of the money-induced inflation. As noted above PMP has been used as a proxy for core inflation in Turkey by many economists. Hence, PMP seems consistent with the properties of the core inflation definition at least time-series wise. There exists a cointegration relation between LM2Y and LPMP at 5% significance level. This relation suggests that there is a

stronger relation between private sector manufacturing prices and monetary policy, than over all price indices. This is also an expected result. However, from the reported ECM summary results in Table 5.b we see that the speed of adjustment coefficient is rather small, suggesting a slower pace in adjustment process.

Utilising the stationarity test reported in Section 2.1. we now move on testing the cointegration relation between CPILFE, CPITM, and CPIWM and LM2Y, pair-wise.

Table 6.

Johansen Cointegration tests of M2Y against CPILFE, CPITM, CPIWM

Sample Range 1994.01 1999.10

	LCPILFE	**LCPITM**	**LCPIWM**
Hypothesis of "No cointegration vector"			
Eigenvalue	0.12	0.06	0.11
Likelihood Ratio	8.22	4.01	7.51
% 5 C.V.	15.41	15.41	15.42
Hypothesis of "1 cointegration vector"			
Eigenvalue	1.02×10^{-3}	2.03×10^{-3}	1.05×10^{-3}
Likelihood Ratio	6.7×10^{-3}	0.13	0.07
% 5 C.V.	3.76	3.76	3.76
Lag Length	4	4	4

Table 6. reports these cointegration test results. At a significance level of 5%, we reject the hypotheses of cointegration between alternative measures and LM2Y. Thus this means that there lies no long run relation between the calculated series and money growth. Thus, as in total inflation, the alternative core inflation measures do not forecast future money growth.

3. Conclusion

In Section 2.1 we have analysed the *internal* consistency of some core inflation measures calculated for Turkey by Cihan and Malatyalı (1999). By internal consistency, we try to define the consistency of the alternative core inflation series obtained by utilising "limited influence estimators", with the total inflation, as these estimators attempts to *remove* the transient part of the total inflation to obtain an inflation series which is the permanent component of the original. Thus, testing this property via cointegration analysis as Freeman (1998) criticizes Bryan and Cecchetti for using simple regression over the difference of the non-stationary data, is referred as internal consistency. First of all, we have concluded that all measures of core inflation are I(1), however, the results of cointegration tests show that we reject the hypotheses of any cointegration relation between the alternative measures and the total price index. Nonetheless, as noted in Section 2.1, these are quite questionable results, mainly due to data restrictions. We have used the CPITM and CPI cointegration relation (at a confidence level of 6%) and analysed the error correction mechanism. We may say that within all three alternatives CPITM shows better internal consistency than the other two. However, for all series evaluated in this study have strong deterministic trends. Additionally, these trend are common. Meaning that while applying the related tests we have accounted for the trend component. Hence, these results imply that core inflation measures does not help forecasting total inflation in the long-run.

In the following section we have tested those alternative measures against the money growth. If a core inflation is to be defined it has to be closely related with the policy makers need of a core inflation. In this study we tried to test this property of the alternative measures by testing them against money supply. In this section, we have also included PMP apart from CPILFE, CPITM, and CPIWM. The main idea behind including this price index in to the analysis was that this series (PMP) has

long been used as a proxy for core inflation rather than using a “derived” measure. PMP performs better than the alternative measures of core inflation. Moreover, PMP reacts quite slowly to the changes in money growth.

Note that, these results highly depends on the sample range. The provided results on LM2Y and LPMP and LCPI comes from a broader sample (1987.01 - 1999.10). However, LM2Y and LCPI are not cointegrated even in this sample range.

Our intuition says the possibility to capture a cointegration relation between money and alternative core inflation measures is high.

References:

- BANERJEE, A., J. DOLADO, J.W. GALBRAITH and D. HENDRY, (1993), "*Co-integration, and the Econometric Analysis of Non-Stationary Data*", Advanced Texts in Econometrics, Oxford University Press.

- BRYAN, M.F. and CECCHETTI, S.G., (1993), "*Measuring Core Inflation*", NBER Working Paper Series, No:4303.

- CİHAN, C., AND MALATYALI, K., (1999), "*Measuring Core Inflation in Turkey*", Unpublished Working Paper.

- ENDERS, W., (1995), "*Applied Econometric Time Series*" John Wiley and Sons.

- FREEMAN, D.G., (1998), "*Do Core Inflation Measures Help Forecast Inflation?*", Economic Letters, 1998-58, 143-147.

- GRANGER, C.W.J. and P. NEWBOLD, (1974), "*Spurious Regressions in Econometrics*", Journal of Econometrics, July 1974-111-120.

- HOFFMAN, D.L. and R.H. RASCHE, (1996), "*Aggregate Money Demand Functions*", Kluwer Academic Publishers.

- SHIRATSUKA, S., (1997), "*Inflation Measures for Monetary Policy: Measuring Underlying Inflation Trend and Its Implication for Monetary Policy Implementation*", IMES Discussion Paper No. 97-E-7.

- WYNNE, M.A., (1999), "*Core Inflation: A Review of Some Conceptual Issues*", ECB Working Paper Series, May 1999, No:5