September 2007
IMF Country Report No. 07/319

Tunisia: Selected Issues

This Selected Issues paper for Tunisia was prepared by a staff team of the International Monetary Fund as background documentation for the periodic consultation with the member country. It is based on the information available at the time it was completed on July 12, 2007. The views expressed in this document are those of the staff team and do not necessarily reflect the views of the Government of Tunisia or the Executive Board of the IMF.

The policy of publication of staff reports and other documents by the IMF allows for the deletion of market-sensitive information.

To assist the IMF in evaluating the publication policy, reader comments are invited and may be sent by e-mail to publicationpolicy@imf.org.

Copies of this report are available to the public from

International Monetary Fund ● Publication Services
700 19th Street, N.W. ● Washington, D.C. 20431
Telephone: (202) 623 7430 ● Telefax: (202) 623 7201
E-mail: publications@imf.org ● Internet: http://www.imf.org

Price: $18.00 a copy

International Monetary Fund
Washington, D.C.

INTERNATIONAL MONETARY FUND

TUNISIA

Selected Issues

Inflation Forecasting and Exchange Rate Pass-Through

Prepared by Abdelhak Senhadji, Tahsin Saadi Sedik, and Kangni Kpodar (all MCD)

Approved by Middle East and Central Asia Department

July 12, 2007

Contents Page

Tables

Appendix Tables

I. Inflation in Tunisia: Trends, Core Inflation, and Forecasting[1]

A. Introduction

1. **Tunisia is gradually moving toward full flexibility of its exchange rate and an inflation-targeting framework.** Forecasting inflation will become a key task for the Central Bank of Tunisia (BCT) because of the time lags between monetary policy and its effects on the economy, particularly on inflation. Thus, to be able to react on time, the BCT will need to base its monetary policy decisions not on past inflation outcomes but on inflation forecasts. The precision with which inflation can be forecasted is a critical element of the inflation targeting framework. For example, it will determine the amplitude of the deviations that are allowed around the inflation target as well as the period over which average inflation should return to the mid-point. To forecast inflation, it is critical to understand Tunisian inflation dynamics and to explore ways to compute core inflation.

2. **The literature suggests several technical requirements as prerequisites for inflation targeting,** including:

> *(i) Institutional independence.* Under inflation targeting, low inflation is the stated primary goal of monetary policy.
>
> *(ii) A healthy financial system*. In order to minimize potential conflicts with financial stabilization objectives and guarantee effective monetary policy transmission, the banking system should be sound and capital markets well developed.
>
> *(iii) Good analytical capabilities and infrastructure*. Data requirements for inflation targeting are more stringent than for alternative regimes and the monetary authorities must have a well developed capacity to forecast inflation.[2]

3. **Tunisia has taken important steps toward an inflation targeting framework,** particularly regarding (i) and (ii). Last year's amendment to the BCT law strengthened the central bank independence and set price stability as the main objective of monetary policy. To invigorate the financial system, the authorities have recently adopted a number of measures aimed at improving the credit culture, promoting good governance, and reinforcing the legal framework for banks. However, a reliable methodology for forecasting inflation is not yet available.

4. **The objectives of this paper are threefold:** (a) analyze trends in Tunisian inflation, (b) compute measures of core inflation, and (c) develop a simple framework for forecasting inflation. The paper is organized around these objectives. The paper ends with some conclusions and policy recommendations.

---

[1] Prepared by Tahsin Saadi Sedik.

[2] See IMF (2006).

B. Trends in Tunisian Inflation

5. **What has been the behavior of Tunisian inflation and the different components of its CPI?** This section compares Tunisia's performance to that of its partners and other countries in the region, and describes the main statistics of the CPI components—weights, mean, median, standard deviation, and trends of each CPI component—over the whole sample period (1991M1–2006M12) and over two sub-periods (1991M1–99M12 and 2000M1–06M12).

6. **Tunisia has achieved price stability for more than a decade.** Supported by the government's outward-oriented strategy, including a conscious price liberalization policy, inflation in Tunisia declined from about 10 percent in early 1990s to about 1 percent in 2005.[3] Prudent monetary and fiscal policies, combined with structural reforms, played a key role in achieving this goal.

7. **Inflation has been moderately volatile, but the volatility has declined since the inflation dropped to the 2–3 percent range.** The volatility of headline inflation—measured by the standard deviation—was 1.7 over the whole period (January 1991–December 2006); it was reduced from 1.7 over January 1991–December 1999 to 1.2 over January 2000–December 2006. Since 2000, headline inflation fluctuated between 1 percent and 5 percent.

8. **Tunisia outperforms a number of other Middle Eastern countries** in terms of low inflation and it compares favorably to trading partners and comparator countries, as indicated in Figures I.1 and I.2.

9. **To investigate the dynamics of Tunisian inflation, we analyze 43 CPI components.**[4] The weights and the main statistics of the components and of six groups (food, housing, clothing, health, transport, services and other) are presented in Appendix Tables I.1–I.3. Table I.1 shows weights and selected statistics for the six groups.

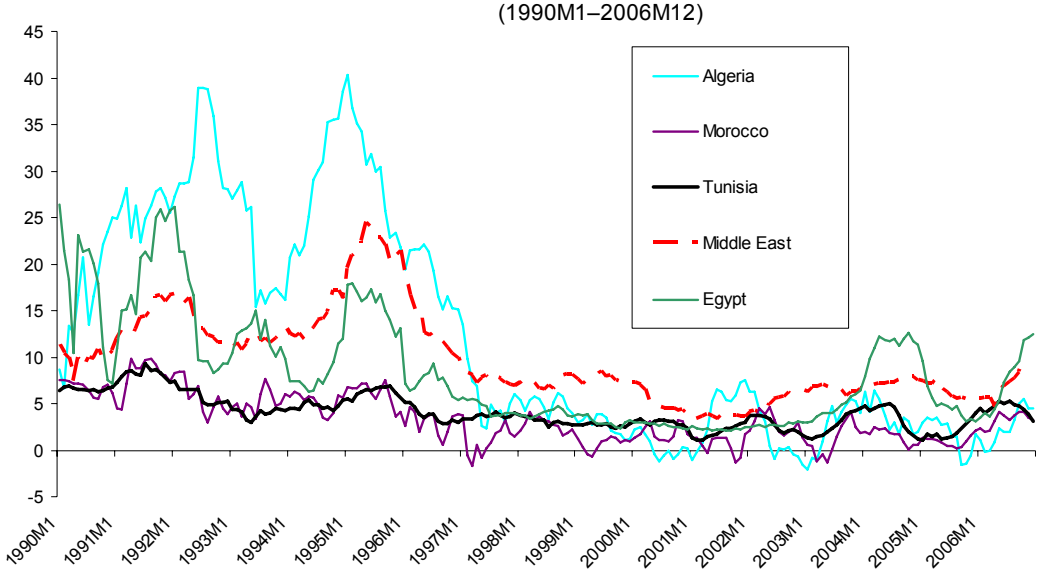
10. **Some components of inflation have been much more volatile than others.** For example, the volatility ranged from 0.4 to 10.2 over 2000–06; it ranged from 0.9 to 12.7 over 1991–99; and it ranged from 0.9 to 11.8 over 1991–2006 (see Appendix Tables I.1–I.3).

---

[3] In this paper, inflation refers to year-on-year monthly inflation, unless otherwise indicated.

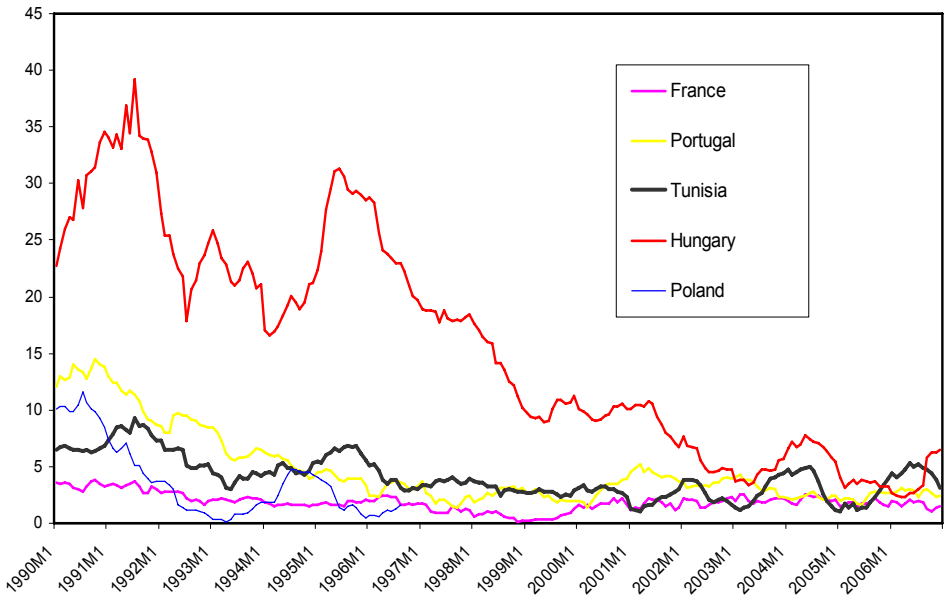
[4] Tunisian CPI index is comprehensive in terms of geographical coverage and number of items in the CPI basket. The CPI index—a Laspeyres index, with 2000 as a base—covers 24 communes representing the capital cities of governorates. Prices are collected by directly surveying a sample of 2631 points of sale. The basket for the index includes 952 products in six groups. Weights are obtained from the 2000 survey of household budgets and consumption. The consumer price index is published in Bulletin Mensuel de Statistique, with the following level of detail: 6 groups and 43 subgroups of products. In this paper, we use this level of detail.

Figure I.1. CPI Inflation, Compared with Neighboring Countries
(1990M1–2006M12)



Source: WEO.

Figure I.2. CPI Inflation, Compared with Main Trading Partners and Comparator Countries
(1990M1–2006M12)



Source: WEO.

Table I.1. CPI Components, Weights, and Selected Descriptive Statistics

(1991M1–2006M12)

	Weights		Descriptive Stats	
	Total	Administered	Mean	SD
General index	**100**	**32.2**	**3.8**	**1.7**
Food	36.5	22.3	4.0	2.5
Housing	17.9	27.5	3.3	1.3
Health	10.5	52.9	3.8	2.1
Transport	10.5	74.5	4.0	2.6
Clothing	11.7	0.0	3.8	2.5
Services and other	12.9	44.6	3.8	2.5

Sources: Tunisian authorities; and IMF staff calculation.

11. **However, most volatile components are the same for the two sub-periods** (Table I.2). For the sub-period 2000–06, energy and transport items are among the ten most volatile groups, reflecting mainly the increase in international prices for oil. Entertainment (spectacles, shows, and performances) and education—two groups of products for which all prices are administered—are not among the ten most volatile for this period. Their lesser volatility is explained by administrative decisions. The five most volatile components are food items: cooking oil, eggs, fruits, vegetables, and meat and poultry. These five items represent about 20 percent of the CPI basket.

Table I.2. Ten Most Volatile CPI Components

1991M1–2006M12		1991M1–99M12		2000M1–06M12	
General Index	**1.7**	**General Index**	**1.7**	**General Index**	**1.2**
Cooking oil	11.8	Cooking oil	12.7	Cooking oil	10.2
Eggs	10.5	Eggs	10.8	Eggs	9.3
Fruits	6.8	Fruits	6.8	Fruits	6.6
Vegetables	5.8	Education	6.0	Vegetables	5.9
Meat and poultry	5.1	Vegetables	5.7	Meat and poultry	4.9
Spectacle, show, performance	5.0	Meat and poultry	5.3	Telecommunication and mail	4.0
Education	5.0	Telecommunication and mail	5.1	Individual transport	3.6
Telecommunication and mail	4.8	Salt	5.1	Salt	2.8
Salt	4.4	Spectacle, show, performance	5.1	Energy products	2.8
Common transport	4.1	Common transport	4.6	Common transport	2.6

Sources: Tunisian authorities, and IMF staff calculation.

12. **A simple regression confirms the persistence in volatility over the two sub-periods.** The regression's dependent variable is the standard deviation (SD) of the 43 CPI components over 2000–06, the independent variable is their SD over 1991–99 and

a constant. Most of the SD differences between CPI components are explained by the previous period's SD since the adjusted R-squared is above 70 percent. This result shows that CPI components that were volatile during 1991–99 remain volatile during 2000–06. However, the coefficient being less than one implies a reduction in volatility over time.

Table I.3. Regression of Standard Deviation over 2000–06 on Standard Deviation over 1991–99

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-0.71	0.27	-2.67	0.01
SD over 1991–99	0.83	0.087	9.53	0.00

Notes: The dependent variable is the Standard Deviation (SD) of the 43 CPI components over 2000–06. The adjusted R-squared is 0.73.

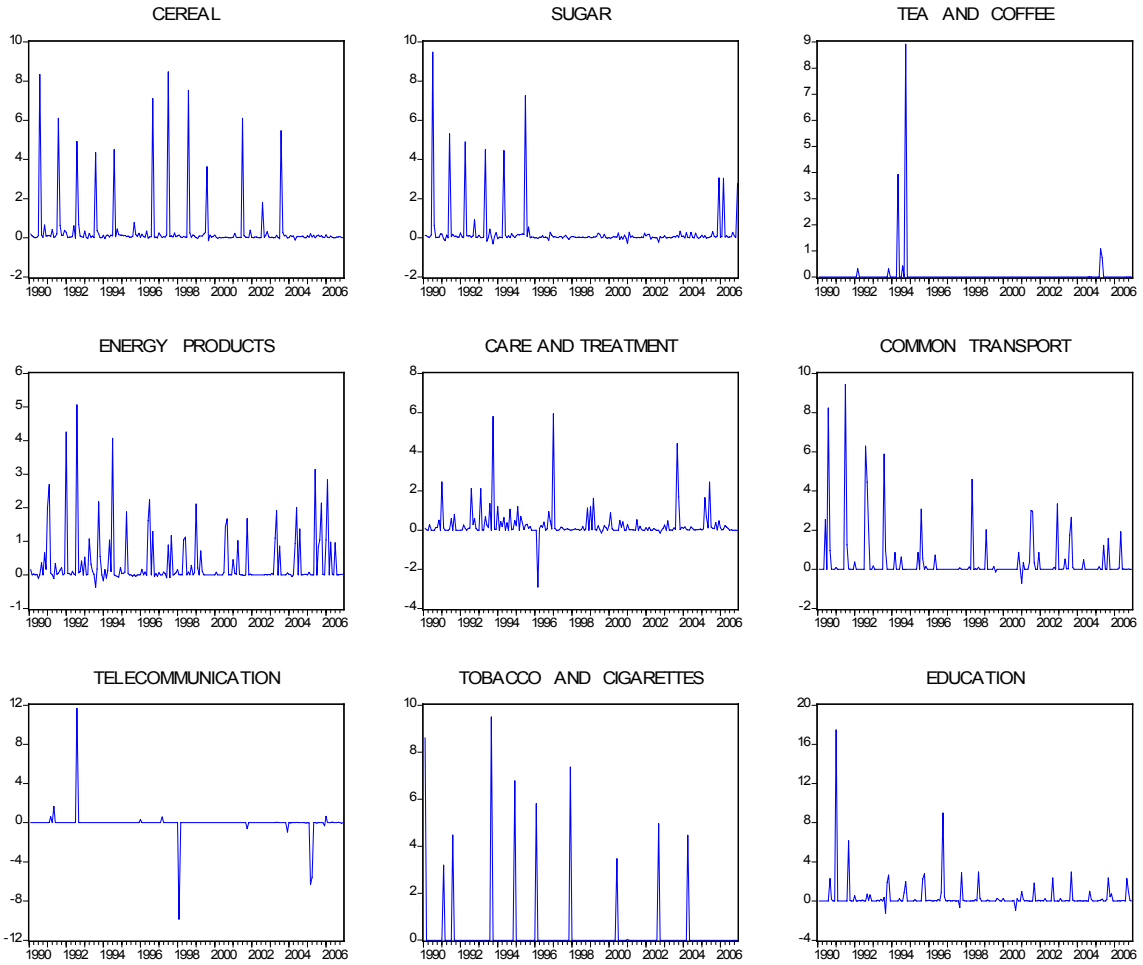
13. **Food remains an important item in the total CPI.** Food represents 36.5 percent of the total weight compared to 41.2 percent in the 1990 household survey. The second group, housing, accounts for about 18 percent; the other four groups represent between 10 percent and 13 percent.

14. **Despite price liberalization, administered prices remain important.** Prices of about 32 percent of the basket are still administered. The prices of some sectors are mainly administered (transport and health); others are partially liberalized (food, housing, and service); and clothing is fully liberalized. Analyzing detailed components shows that more than 50 percent of the prices of the following components are administered: tobacco (100 percent), telecom (100), common transport (100), care and treatment (100), energy (97), coffee and tea (87), cereals (71), sugar (59), and education (57).

15. **Changes in administered prices are irregular.** The month-on-month inflation of these components, shown in Figure I.3, illustrates clearly that inflation changes are discretionary for these items. Thus, Tunisia's inflation is partially driven by administrative decisions.

16. **The large share of administered prices constitutes a major impediment to an inflation targeting framework.** The BCT does not have any influence on one third of the CPI basket because the government fixes the administered prices. Even if the BCT coordinates with the government, the mechanism for adjusting administered prices introduces

Figure I. 3. Behaviors of Administered Prices (month-on-month; 1990–2006)



Sources: Tunisian authorities, and IMF staff calculations.

a fiscal bias into the control of inflation.[5] Monetary policy looses its flexibility and effectiveness in the presence of a large share of administered prices. This is particularly important in the case of an inflation targeting framework where inflation forecasting and the ability to swiftly respond to shocks are crucial.

17. **Recent fluctuations in overall CPI inflation have resulted mainly from increases in the prices of food items, transport, and energy.** Food and transport have contributed to overall inflation more than their respective weights during 2000–06. Their contribution to overall inflation was about 56 percent compared to their weight of 47 percent (Table I.4 and Appendix Table I.4).

[5] Controlling inflation by keeping administered prices unchanged may lead to an implicit accommodation of budgetary slippages, that is, an increase in subsidies.

Table I.4. Average Contribution to Overall Inflation by Different Groups

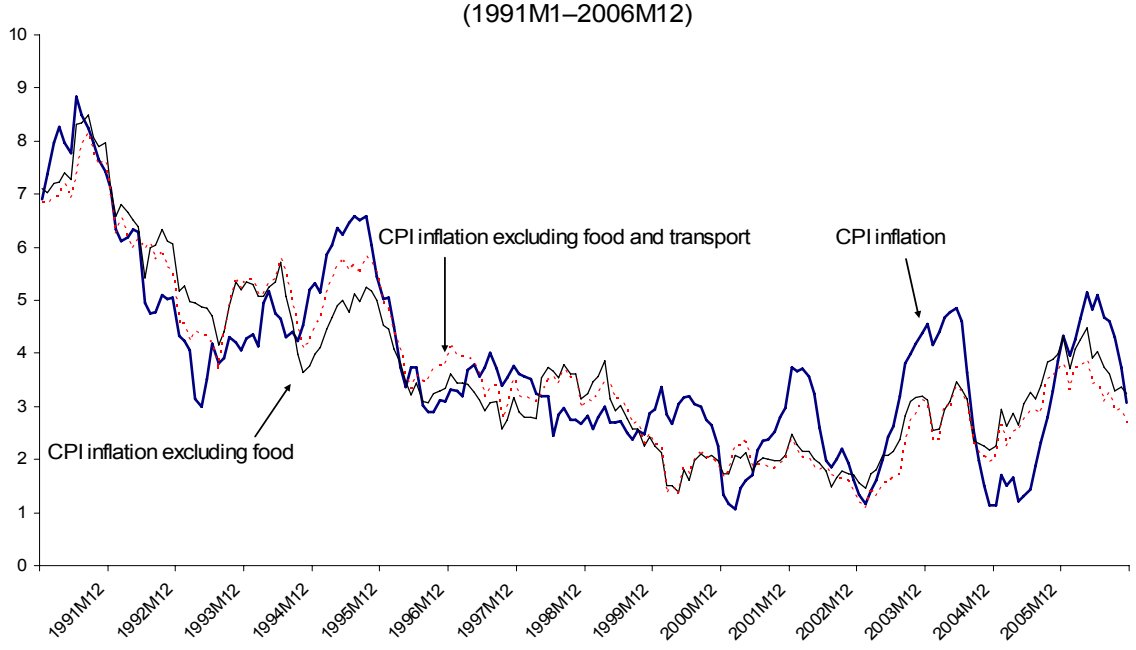
(In percent)

	Weights	1991M1–2006M12	1991M1–99M12	2000M1–06M12
General index	**100.0**	**100.0**	**100.0**	**100.0**
Food	36.5	38.3	36.0	43.1
Housing	17.9	15.5	14.9	16.9
Health	10.5	10.5	10.8	9.9
Transport	10.5	10.9	9.9	13.0
Clothing	11.7	11.7	14.0	7.0
Services and other	12.9	12.9	14.7	9.3

Sources: Tunisian authorities, and IMF staff calculations.

18. **Food and transport contribute significantly to the volatility of headline inflation (Figure I.4).** While the standard deviation of inflation was 1.2 during January 2000 to December 2006, that of inflation without food was 0.8, and that of inflation without food and transport was 0.7. Measuring core inflation is the subject of the next section.

Figure I.4. CPI Inflation With and Without Food and Transport Prices
(1991M1–2006M12)



Sources: Tunisian authorities, and IMF staff.

C. Measures of Core Inflation for Tunisia

Based on the analysis of Section B, Section C presents three measures of core inflation. Our preferred measure is based on excluding the five most volatile CPI components.

19. **A credible measure of inflation to be targeted is key to the success of inflation targeting.** The headline CPI is generally modified for this purpose by excluding the most volatile CPI components such as food (because of weather conditions) and energy (because of supply shocks). Potentially, any volatile component of CPI may be excluded from the "core inflation". However, the rationale for excess volatility should also be explained.

20. **Of course, there is no perfect measure of core inflation.** There are many alternative approaches to the one based on exclusion.[6] The choice of a particular measure of core inflation is country-specific. In some cases, headline inflation is a preferred target if the measure of core inflation is not credible.

21. **We present three measures of core inflation based on exclusion.** Two measures are based on excluding the most volatile CPI components and one on excluding administered prices. Exclusion-based core inflation measures have many advantages compared to other measures. They are transparent, easy to understand, replicable, credible, and available on a timely basis. For these reasons, exclusion-based methods are often used by countries in their initial stage of inflation targeting.

Excluding most volatile CPI components

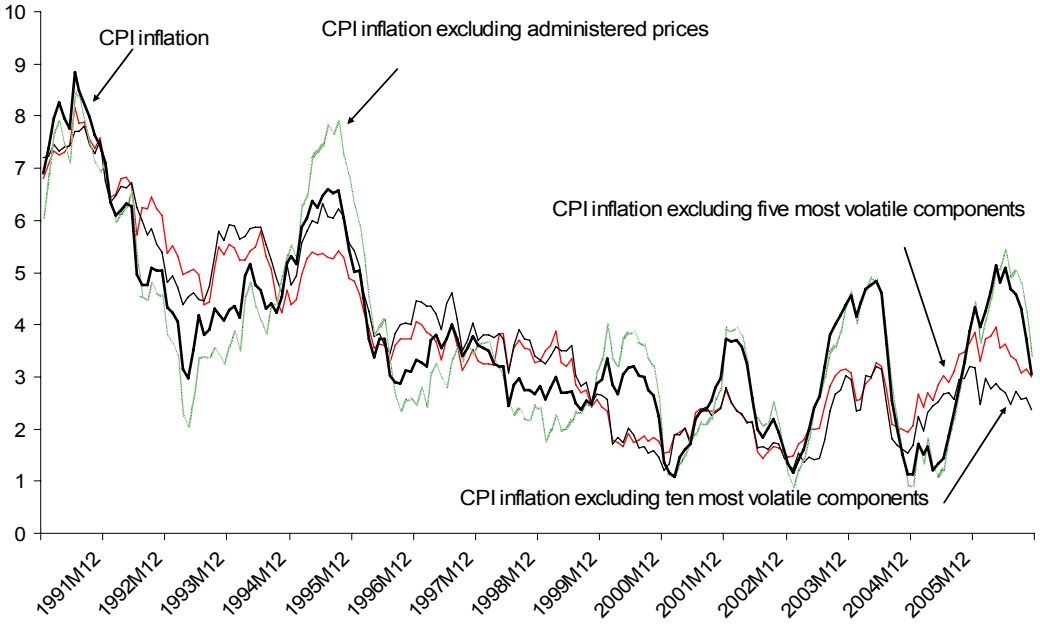
22. **The first measure eliminates CPI components that are considered to be particularly volatile.** Thus, they give implicitly more weight to component price indices that are less subject to shocks. A widespread approach is simply to exclude certain product groups such as food and energy because of their perceived excessive volatility. However, this is problematic in emerging and developing countries, since food items represent a large share in the CPI basket. In the case of Tunisia, food counts for 36.5 percent of the basket. Such exclusions may erode the credibility of the measure.

23. **Instead of excluding perceived volatile CPI groups, we examine 43 CPI components to determine which are the most volatile** (see Section B). The usual shortcoming of this procedure is that the components that are found to be volatile may become relatively stable over time, and vice versa. However, in Tunisia the ten most volatile components are broadly the same for the two sub-periods. We computed two measures based on the volatility of CPI components, namely by eliminating the five and ten most volatile CPI components (Figure I.5). Over 2000–06, these two measures are respectively 42 and

[6] See Silver (2006) for a survey on core inflation measures and statistical issues in choosing among them.

53 percent less volatile than headline inflation. Nevertheless, they remain highly correlated with headline inflation; the simple correlation is about 0.7 for both measures. These measures remove about 20 percent and 37 percent from the CPI basket, respectively.

Figure I.5. Core Inflation: Excluding Administered Prices; Top Five and Top Ten Most Volatile CPI Components



Sources: Tunisian authorities, and IMF staff calculation.

Excluding administered CPI components

24. **The second measure leaves out administered CPI components.** Changes in administered prices are irregular and often large and thus have temporary effect on prices, warranting their exclusion. On the other hand, they form part of the inflationary process and should be included. We compute a measure of core inflation, excluding administered items, defined as items where administered prices cover over 50 percent of sub-components (see Figure I.3). Core inflation based on excluding administered CPI components is highly correlated with headline inflation; the simple correlation is 0.98 over 2000–06. However, it is 8 percent more volatile than headline inflation over the same period.[7] This measure removes about 30 percent of the CPI basket.

[7] This measure has a major shortcoming, namely the exclusion is based on aggregate CPI components—full details of CPI components are not available. However, the authorities could compute and use the "free" core inflation.

25. **Overall, the best measure is the one based on excluding the five most volatile CPI components.** The measure excluding administered prices has a major shortcoming, in that it is not operational at a relatively high level of aggregation. In other words, it is not possible to separate the administered part of each component given the aggregation level. The measure excluding the top five is preferable to the one excluding the top ten. Because it removes only 20 percent of the CPI basket while reducing the volatility by 42 percent (compared to respectively 37 percent and 53 percent for the measures based on excluding the top ten). Furthermore, the five most volatile components have remained the same over time[8] while some of the top ten components have changed over the two sub-periods.

D. Can Inflation be Forecasted in Tunisia?

26. **Among the forecasting models of core and headline inflation, the preferred approach is a leading indicator model.** The results show that, even with limited monthly observations, economically meaningful and statistically significant relations can be established between leading indicators and the future direction of inflation. Nevertheless, the results remain fragile due to (a) the relatively small sample period and the lack of relevant data; and (b) the administered prices, an important obstacle to forecast Tunisia's inflation.

Background, data sample, and lead period

Background

27. **There is a large and growing empirical literature on inflation forecasting**. Studies of inflation forecasts are mostly on advanced economies. At least three factors may account for this. First, the predominance of agriculture in emerging markets makes inflation more dependent on weather than economic activity (e.g., the Phillips curve). Second, limitations of data quality and frequency are often constraining factors. Third, emerging markets are prone to sudden crises and market gyrations in macroeconomic variables, making it difficult to discern economic regularity. However, a rapidly growing literature has begun to analyze inflation forecasts in emerging markets and to construct leading indicators for inflation.[9]

28. **Theoretical work shows that short- and long-term determinants of inflation are different.** In the long term, inflation is a monetary phenomenon with flexible prices and wages and output and employment always at their natural rates. In the short run, inflation also results from real and nominal shocks that affect aggregate demand relative to aggregate supply. Monetary financing of public spending also contributes to inflation (see the literature on the inflation tax). In open economies, inflation can result from movements in the nominal exchange rates. Finally, inflation expectations and their formation affect inflation through price-wage spirals or inertia.

---

[8] However, education—an administered item—is among the top five for 1991–99.

[9] For example, Chauvet (2000) for Brazil; Leigh and Rossi (2002) for Turkey; Sun (2004) for Thailand; Bokil and Schimmelpfennig (2004) for Pakistan.

29. **The empirical determinants of inflation are consistent with theory.** Changes in money growth, nominal exchange rates, price of imports, and exogenous supply shocks, especially to oil and food prices, are the main determinants of inflation in emerging market economies.

Data sample

30. **The choice of data sample for forecasting inflation in Tunisia is dictated by data availability.** The data sample analyzed here comprises monthly observations of 20 variables from different sectors of the economy from December 1997 to December 2006 (109 observations).[10] The sample is reduced because some monetary variables are only available from December 1996.[11] We use 12-month growth rates of variables to take into account seasonality. All variables were tested in logarithmic form for nonstationarity using Phillips-Perron and Augmented Dickey-Fuller tests. The unit root hypothesis could not be rejected for some of the variables in levels. However, all variables in first differences (i.e., the growth rate) were found to be stationary. The regressions below are therefore expressed in first differences to avoid spurious correlations associated with nonstationary variables.[12]

Lead period

31. **Forecasting inflation requires determining a "lead period",** defined as the number of months for which leading indicators would predict inflation. We use four lead periods: 3, 6, 9, and 12 months.[13]

The alternative models

32. We forecast headline inflation and two measures of core inflation—excluding top five and top ten most volatile CPI components.[14] We start with two benchmark models, namely the naïve model and ARMA model. Then we present other specifications and compare their results to those of the two-benchmark models.

---

[10] In addition, we use industrial production index (IP) components and groups (47 variables).

[11] We use year-on-year growth rates of variables. Thus, in practice, the first observation is December 1997.

[12] For the main variables, the results of these tests are reported in Appendix II.1. For the other variables, the results are available upon request.

[13] In theory, a lead period could be endogenously determined, namely through a search of the highest joint statistical significance for all combinations of indicators and lead periods. But in practice, this is difficult to compute and may not be optimal in terms of providing a valuable indicator for policy decisions.

[14] We do not use the measure of core inflation excluding the administrated prices because it is highly correlated with headline inflation.

Naïve model

33. ***The first step—as a benchmark—is to assume that inflation cannot be forecasted.*** Thus, no other model can beat a random walk, which implies that the best forecast for future inflation is current inflation.[15]

34. **The naïve model performs poorly in the case of Tunisia.** This is not surprising, because inflation has been relatively volatile ranging between 1 and 5 percent over 2000M1–06M12. The naïve model performs quite well when inflation fluctuates moderately.

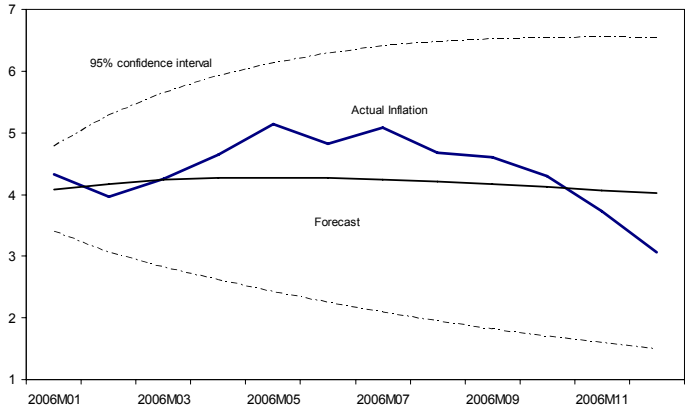
Autoregressive Moving-Average (ARMA) models

35. **ARMA models use only past inflation observations to forecast inflation.** As a second benchmark, we use the forecast from ARMA models allowing the disturbances to follow an ARMA specification. We estimate the following ARMA(p,q) model that includes both autoregressive and moving average terms:[16]

$$\pi_t = c + \sum_{i=1}^{p} \phi_i \pi_{t-i} + \sum_{j=0}^{q} \theta_j \varepsilon_{t-j} \qquad (1)$$

36. **The best specification is an ARMA(2,2) model, which predicts actual inflation reasonably well.**[17] We started with a large p and q, and then eliminated all lags that were not significant. The results for 12-months forecasting horizons for headline inflation are presented in Figure I.6. The forecast fails to predict the turning points. However, it predicts a small decline in inflation.

Figure I.6. Performance of the ARMA Model



Sources: Tunisian authorities, and IMF staff estimates.

[15] Atkeson and Ohanian (2001) showed that a random-walk forecast outperforms a Phillips curve-based inflation forecast for the United States.

[16] See Hamilton (1994; Chapters 3 and 4) for a discussion on forecasting with ARMA models.

[17] The root mean square error (RMSE) for 12-months forecasting horizon of headline inflation is 0.54.

Forecasting inflation by using a formal model: Phillips curve representation

37. **The Phillips curve has been used extensively in inflation forecasting, but does not have a strong predictive power for Tunisia.** Although the Phillips curve is typically specified in terms of the deviation of unemployment from its natural rate, more generally it is a relationship between inflation and aggregate real activity (deviation of output relative to its potential, i.e., output gap). Following Stock and Watson (1999), we assume that the potential economic activity is constant over the short-term period. Thus, the relationship becomes between inflation and economic activity:

$$\pi_{t+h} = \alpha + \beta(L)X_t + \gamma(L)\pi_t + \varepsilon_{t+h} \qquad h = 0,3,6,9,12 \tag{2}$$

Where, π_{t+h} is the inflation *h* months ahead (henceforth, referred to as h-period inflation); X_t is a proxy of the economic activity; $\beta(L)$ *and* $\gamma(L)$ are polynomials in the lag operator L; and ε_{t+h} is the error term.

Following the literature, industrial production index (IP) is taken as a proxy of economic activity. We tried many specifications of the above equations (including h=0); IP was significant only in few cases. However, even in these cases, IP can only explain a small part of the variability of inflation. From these regressions, we conclude that even if the Phillips curve had some explanatory power under certain specifications, still most of the variability of inflation remains to be explained. And it cannot be used alone to produce accurate forecasts of inflation.

Leading indicators

38. **Without having a formal model, we analyze the correlation between inflation and a set of variables—including the industrial production index—from different sectors.** Then, we combine the best individual leading indicators into an index. In our preferred model, nominal effective exchange rate, a monetary aggregate—namely M4—and the producer price index are found to be good leading indicators. They perform relatively well for 3, 6, 9, and 12 months-lead periods and for the different measures of core and headline inflation.

Individual leading indicators

39. **First, we select the best individual leading indicators.** We run bivariate regressions of h-period inflation on a large number of potential leading indicators. We estimate equation (2) and fix the number of lags to 3, where X_t is a potential leading indicator for inflation. Only few variables are statistically significant with the expected sign. The main results for the bivariate regressions are presented in Appendix Table I.5. The following variables are significant in one of the models: nominal effective exchange rate (NEER), M2, M4, credit to the economy, industrial production index, producer price index, and Tunis stock market index.

Index of leading indicators

40. **Second, we combine the individual leading indicators into an index of leading indicators, because a composite leading index is superior to a single leading indicator.** Indeed, a composite index reflects a broader spectrum of the economy, comprising data from several sectors. Moreover, the performance of an individual series may vary over time, making it occasionally a poor leading indicator. In statistical terms, this implies that a composite index reduces the measurement error associated with any given indicator.

41. **The selection of variables to be included in the regression is based on a principle of parsimony**, also used in Stock and Watson (1989), and Mongardini and Saadi-Sedik (2003). From a generalized model using all potential indicators (Appendix Table I.5), variables were recursively eliminated based on the lowest t-statistic. Attention was also paid to avoid multicollinearity for variables that were close proxies.[18]

42. The selection procedure outlined above identified the following model that produced consistently superior results:

$$\pi_{t+h} = \alpha + \beta_1 \pi_t + \beta_2 \pi_{t-1} + \gamma_1 NEER_t + \gamma_2 M4_t + \gamma_3 PPI_t + \varepsilon_{t+h} \qquad h = 3,6,9,12 \tag{4}$$

The three leading indicators are the Nominal Effective Exchange Rate (NEER), a monetary aggregate (M4), and Producer Price Index (PPI). In addition, the current level of inflation and a lag are significant. The results for the three measures of inflation and four lead periods are presented in Appendix Table I.6.

These results are also intuitive from an economic point of view:

- NEER. This is consistent with the empirical determinants of inflation found in the literature. See also the Chapter II on exchange rate pass-through. Everything being equal, a 10 percent depreciation of NEER is forecast to increase headline inflation of about 1 percent twelve months ahead.

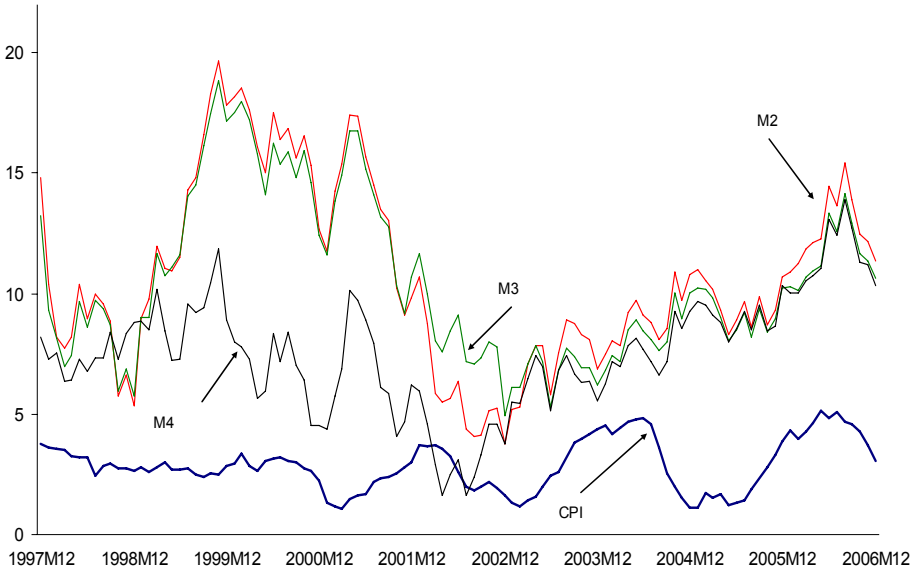
- M4. The results show that M4 is the best monetary aggregate as a leading indicator for inflation. An increase of 10 percent of M4 is forecasted to increase headline inflation of about 0.4 percent twelve months ahead. Monetary aggregates have not been closely related to inflation because portfolio shifts between aggregates have contributed to their instability. High money growth reflected in part a decline in M3 velocity as the demand for savings and time deposits rose. This was due to investor portfolio shifts away from government securities, which enjoyed a liquidity guarantee

[18] As an alternative, we use the General-to-Specific methodology (Hendry, 2001) as implemented in the PcGets software. The problem with this methodology is that the results are not always meaningful from an economic point of view. Therefore, the results of this methodology are not reported.

from commercial banks (*Bons du Trésor Cessibles or BTCs*). The broader liquidity aggregate (M4), which includes BTCs, is more stable. However, for the recent period the correlation between M2, M3, and M4 becomes higher (see Figure I.7).

- PPI. This is also consistent with the literature (e.g., Stock and Watson, 1999). An increase of 10 percent of PPI is forecast to increase headline inflation of about 0.8 percent twelve months ahead. The PPI is a comprehensive index of wholesale price index, which is often viewed as an indicator of future retail price index (i.e., CPI index).

Figure I.7. Inflation and Monetary Aggregates (year-on-year, Monthly Growth Rates)



Source: Tunisian authorities.

43. **The explanatory power decreases as the forecast horizon increases.** The R-square decreases from about two-thirds for the three months horizon to about one-third for the twelve months. However, for the headline inflation the R-square for twelve months is similar to that of three months.

Pseudo out-of-sample performance[19]

44. The main conclusion is that the two measures of core inflation produce better pseudo forecasts.

[19] We refer to "Pseudo" out-of-sample because the actual values of inflation are observed.

45. **The twelve specifications presented in Appendix Table I.6 can be used to measure their pseudo out-of-sample performance based on the last h-months.** For example, the pseudo-forecast for the last six months of 2006 (h=6) requires estimating the model using data available through 2006M06, then using this estimated model to produce the 2006M07–2006M12 forecast.

46. **Forecasts' accuracy is measured by the forecasting error.** The measure used is Root Mean Square Error (RMSE) computed as the square root of the arithmetic average of the squared differences between actual inflation and predicted inflation over the period for which simulated forecast are constructed (see bottom of Appendix Table I.6). The RMSE indicates a superior forecast results for the two measures of core inflation when compared to the headline inflation.

47. **The confidence interval of the forecast is relatively wide.** This implies that the mid-point inflation target band should be relatively wide to take into account the imprecision of the inflation forecasts.[20] More importantly, however, the statistical tools (including databases) should be developed to improve the accuracy of these forecasts.

E. Conclusions and Policy Recommendations

Conclusions

48. To investigate the nature of the Tunisian inflation process, we analyze the behavior of 43 CPI components and six groups (food, housing, clothing, health, transport, services). We find that some components of inflation have been much more volatile than others. However, the most volatile components remain broadly the same over time. We also find that, despite price liberalization, administered prices remain an important component of the CPI total index (about 32 percent). The prices of some sectors are mainly administered (transport and health); others are partially liberalized (food, housing, and service); and clothing is fully liberalized.

49. Based on the behavior of the 43 CPI components, three measures of core inflation are computed. They are based on the exclusion method. Two measures exclude the most volatile CPI components—namely the top five and top ten most volatile components. The third measure leaves out the components with predominantly administered prices. Our preferred measure is based on excluding the five most volatile CPI components because it removes fewer components, it is transparent, easy to understand, replicable, credible, and available on a timely basis.

[20] This is consistent with the range widths for other emerging countries. Medium-term target levels for 12-month inflation rates are between 1 percent and 3 percent, and ranges are usually close to 2 percentage points wide (i.e., the target rate plus or minus 1 percentage point). See Roger and Stone (2005).

50. Assessing the direction of inflation is essential for the formulation of appropriate monetary policies in the context of inflation targeting framework. In this regard, composite indexes of leading indicators for inflation provide useful summary statistics.

51. Although we present several empirical models to forecast Tunisia's core and headline inflation, our preferred approach is a leading indicator model. In this model, nominal effective exchange rate, a monetary aggregate—namely M4—and the producer price index are found to be good leading indicators. They perform relatively well for 3, 6, 9, and 12 months-lead periods and for the different measures of inflation. These results show that, even with limited monthly observations, meaningful economic and statistically significant relations can be established between leading indicators and the future direction of inflation.

52. Notwithstanding the relatively small sample period, the results seem to be both statistically significant and economically intuitive. However, a larger sample will be needed before the composite indexes for the Tunisian inflation can be relied upon for more than a qualitative assessment. Also, important data for inflation forecasting are not available on a monthly basis (for example, prices for imports). Their availability will increase the precision of inflation forecast.

53. In addition, assessing future inflation will always need to take account of other information that cannot easily be quantified, including geopolitical uncertainties and macroeconomic policy changes. Despite these caveats, a regular updating of these indexes could provide useful information and help monetary policy formulation.

Policy recommendations

- **Strengthen analytical research at the BCT.** The BCT should strengthen and broaden its research capacity and develop forecasting skills with respect to inflation and other relevant macroeconomic variables.
- **Administered prices should be reduced.** Administered prices are a major impediment to implementing efficiently inflation targeting. The BCT does not have any control on one third of CPI basket. This is an important obstacle to forecasting Tunisia's inflation. In addition, the mechanism for adjusting administered prices introduces a fiscal bias into the control of inflation in the sense that the inflation target may lead to an implicit accommodation of budgetary slippages.
- **Need of a multivariate model.** While the focus of this paper is on inflation, monetary policy makers need to be informed about the future evolution of other variables, such as real GDP growth. Therefore, the forecasting model is typically multivariate, including at a minimum inflation and real GDP forecasts.
- **More data are required.** As mentioned above, statistical data are needed to increase forecast accuracy, in particular, monthly import prices, other indicators of economic

activity (in addition to the industrial production index) such as retails sales, and forward looking business and consumer confidence indicators.

REFERENCES

Atkeson, Andrew, and Lee Ohanian, 2001, "Are Phillips Curves Useful for Forecasting Inflation?" FRB Minneapolis Quarterly Review (Winter), pp. 2–11.

Canales-Kriljenko, Jorge Ivan, Turgut Kışınbay, Rodolfo Maino, and Eric Parrado, 2006, "Setting the Operational Framework for Producing Inflation Forecasts", IMF Working Paper No. 06/122 (Washington: International Monetary Fund).

Chauvet, Marcelle, 2000, "Real Time Leading Indicators of the Brazilian Inflation." Available via the Internet at http://faculty.ucr.edu/~chauvet/mc.htm.

Fisher Jonas D. M., Chin Te Liu, and Ruilin Zhou, 2002, "When Can We Forecast Inflation?" FRB Chicago Economic Perspectives (1Q), pp. 30–42.

Hamilton, James D., 1994, "Time Series Analysis," Princeton University Press, Princeton, New Jersey.

Heenan, Geoffrey, Marcel Peter, and Scott Roger, 2006, "Implementing Inflation Targeting: Institutional Arrangements, Target Design, and Communications", IMF Working Paper No. 6/278 (Washington: International Monetary Fund).

International Monetary Fund, 2006, "Inflation Targeting and the IMF" IMF Board paper, available via the Internet at: www.imf.org/external/np/pp/eng/2006/031606.pdf.

Leigh, Daniel, and Marco Rossi, 2002, "Leading Indicators of Growth and Inflation in Turkey," IMF Working Paper No. 02/231 (Washington: International Monetary Fund).

Marcellino, Massimiliano, 2005, "Leading Indicators: What Have We Learned?" IGIER Working Papers No. 286 (Bocconi University).

Madhavi, Bokil, and Axel Schimmelpfennig, 2004, "Three Attempts at Inflation Forecasting in Pakistan", IMF Working Paper No. 05/105 (Washington: International Monetary Fund).

Mongardini, Joannes, and Tahsin Saadi-Sedik, 2003, "Estimating Indexes of Coincident and Leading Indicators: An Application to Jordan," IMF Working Paper No. 03/170 (Washington: International Monetary Fund).

Roger, Scott, and Mark Stone, 2005, "On Target? The International Experience with Achieving Inflation Targets", IMF Working Paper /05/163 (Washington: International Monetary Fund).

Silver, Mick, 2006, "Core Inflation Measures and Statistical Issues in Choosing Among Them", IMF Working Paper /06/97 (Washington: International Monetary Fund).

Sun, Tao, 2004, "Forecasting Thailand's Core Inflation", IMF Working Paper/04/90 (Washington: International Monetary Fund).

Stock, James H., and Mark W. Watson, 1989, "New Indexes of Coincident and Leading Economic Indicators," *NBER Macroeconomic Annual Report* (Cambridge, Massachusetts: National Bureau of Economic Research), pp. 351–94.

_____, 1999, "Forecasting Inflation," *Journal of Monetary Economics*, Vol. 44, pp. 293–335.

_____, 2003, "Forecasting Output and Inflation: the Role of Asset Prices," *Journal of Economic Literature*, Vol. XLI, pp. 788–829.

Appendix Table I.1. CPI Components, Weights, and Main Descriptive Statistics (1991M1–2006M12)

	Weights		Descriptive Stats							
	Total	Administered	Mean	Median	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Jarque-Bera
General index	**100.0**	**32.2**	**3.8**	**3.6**	**8.8**	**1.1**	**1.7**	**0.8**	**3.3**	**20.3**
Food	**36.5**	**22.3**	**4.0**	**3.9**	**9.9**	**-1.7**	**2.5**	**0.1**	**2.5**	**2.3**
Cereal	5.4	70.7	5.1	5.9	16.3	0.1	3.3	0.1	2.7	1.6
Meat and poultry	7.0	0.0	4.9	4.2	19.3	-6.4	5.1	0.6	2.8	12.2
Fish	1.6	0.0	5.3	4.6	15.7	-1.7	3.9	0.8	3.2	23.0
Eggs	1.0	0.0	1.7	1.6	31.1	-34.6	10.5	-0.1	3.6	3.3
Milk	3.8	44.7	3.7	3.1	11.5	0.1	2.9	0.9	3.0	26.8
Oil	1.8	37.0	5.3	2.3	44.1	-17.6	11.8	1.0	4.0	39.3
Vegetables	5.3	0.0	2.8	2.6	15.9	-10.4	5.8	0.1	2.3	4.2
Salt	1.0	2.3	3.1	2.5	18.2	-9.8	4.4	0.5	4.0	16.2
Fruits	5.5	0.0	3.1	4.2	16.7	-12.2	6.8	-0.3	2.4	5.9
Sugar	1.8	59.4	3.0	0.9	15.8	-0.1	3.3	1.0	3.1	32.1
Tea and coffee	0.8	87.1	1.0	0.0	13.6	0.0	2.9	3.4	13.7	1282.5
Non alcoholic drinks	1.2	0.0	4.8	4.9	10.6	0.0	2.7	0.2	2.1	7.8
Alcoholic drinks	0.3	46.3	4.3	4.1	12.9	0.0	3.1	0.7	3.2	15.9
Housing	**17.9**	**27.5**	**3.3**	**3.1**	**6.9**	**1.0**	**1.3**	**0.7**	**3.0**	**14.6**
Rent	4.2	7.8	3.8	3.3	8.1	0.9	1.8	0.6	2.5	15.1
Maintenance and repairing	2.2	0.0	2.4	1.5	10.3	0.1	2.3	1.7	5.0	119.4
Energy products	4.7	97.0	4.3	4.0	12.0	0.0	2.5	0.7	3.7	20.1
Furniture and bedding	2.4	0.0	3.4	2.5	13.9	0.6	2.9	2.0	7.0	255.3
Household appliance	1.9	0.0	1.7	1.1	10.9	-0.6	2.0	2.6	10.0	603.4
Dishes and cooking utensils	1.1	0.0	1.9	1.8	4.6	0.0	0.9	0.6	3.3	11.8
Furniture items	1.4	0.0	3.5	3.6	7.4	0.5	1.8	0.2	1.9	9.9
Health	**10.5**	**52.9**	**3.8**	**4.2**	**8.5**	**0.4**	**2.1**	**0.2**	**1.9**	**11.3**
Washing items	1.9	0.0	3.8	3.4	11.7	0.1	2.6	1.2	4.3	60.5
Maintenance products and detergent	1.5	0.0	4.5	3.3	19.4	-2.1	3.0	1.2	5.2	82.6
Hygiene service	1.6	0.0	4.3	3.9	13.6	1.0	2.6	1.9	7.3	269.0
Care and medicines	5.5	100.0	3.5	3.3	11.6	-1.8	2.9	0.6	2.8	11.8
Transport	**10.5**	**74.5**	**4.0**	**3.3**	**13.5**	**0.4**	**2.6**	**0.9**	**3.1**	**24.1**
Common transport	3.8	100.0	4.5	3.6	18.7	-0.1	4.1	0.9	2.9	23.8
Individual transport	5.4	50.3	4.1	3.6	12.8	0.0	3.1	0.8	2.8	22.7
Telecommunication and mail	1.4	100.0	-0.5	0.0	11.7	-12.3	4.8	-0.2	5.3	42.3
Clothing	**11.7**	**0.0**	**3.8**	**3.5**	**8.8**	**-0.9**	**2.5**	**0.4**	**2.2**	**9.9**
Clothes for men	2.0	0.0	3.9	3.0	11.7	-3.6	3.4	0.4	2.3	9.4
Underwear for men	0.1	0.0	3.6	2.6	16.2	-2.2	3.4	1.6	6.1	162.3
Clothes for women	1.9	0.0	3.2	3.0	9.7	-4.1	2.6	0.4	3.0	5.3
Underwear for women	0.4	0.0	3.7	3.3	13.6	-2.9	3.0	1.4	5.5	113.5
Clothes for children	2.2	0.0	3.8	3.0	11.4	-2.1	2.9	0.9	3.2	24.0
Secondhand clothes	1.1	0.0	4.8	3.7	11.1	0.1	3.2	0.4	1.8	16.5
Wearing accessories	0.4	0.0	3.0	2.6	8.7	-0.2	2.1	0.8	2.8	19.4
Shoes	2.9	0.0	4.1	3.9	13.4	-2.8	3.2	0.5	3.1	7.7
Fabric	0.3	0.0	3.0	1.6	17.7	-1.8	3.8	2.0	7.3	283.0
Expenses related to clothing	0.3	0.0	3.1	2.7	10.9	-3.8	2.6	1.0	4.3	47.7
Services and other	**12.9**	**44.6**	**3.8**	**2.8**	**12.6**	**0.8**	**2.5**	**1.5**	**5.0**	**101.2**
Tobacco and cigarettes	2.9	100.0	3.2	3.5	9.5	0.0	3.3	0.4	1.7	17.8
Leisure items	1.4	0.0	1.6	0.8	7.9	-2.0	2.1	0.9	3.3	28.4
Spectacle, show, performance	0.3	0.0	5.0	3.2	23.2	-8.7	5.0	1.1	4.2	53.3
Drinks and meals	4.4	25.6	4.8	3.7	12.0	0.7	2.9	1.0	2.8	29.8
Education	3.0	57.0	4.5	3.2	23.8	-0.5	5.0	2.5	8.9	474.2
Culture	0.8	0.0	3.3	2.5	9.0	-1.4	2.5	0.6	2.4	14.4

Sources: Tunisian authorities, and IMF staff calculations.

Appendix Table I.2. CPI Components, Weights, and Main Descriptive Statistics (1991M1–99M12)

	Weights		Descriptive Stats							
	Total	Administered	Mean	Median	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Jarque-Bera
General index	**100.0**	**32.2**	**4.6**	**4.2**	**8.8**	**2.4**	**1.7**	**0.8**	**2.7**	**11.9**
Food	**36.5**	**22.3**	**4.5**	**4.0**	**9.9**	**0.3**	**2.4**	**0.6**	**2.3**	**8.6**
Cereal	5.4	70.7	6.9	7.2	16.3	0.9	2.7	0.1	4.5	9.8
Meat and poultry	7.0	0.0	5.0	4.5	19.3	-6.4	5.3	0.5	3.0	4.5
Fish	1.6	0.0	7.1	6.0	15.7	-0.5	4.0	0.5	2.3	6.9
Eggs	1.0	0.0	2.1	2.5	31.1	-34.6	10.8	-0.4	4.7	15.9
Milk	3.8	44.7	5.3	4.9	11.5	0.5	2.9	0.4	2.4	4.0
Oil	1.8	37.0	2.4	1.0	44.1	-17.6	12.7	1.5	5.0	58.2
Vegetables	5.3	0.0	3.2	2.5	15.9	-8.1	5.7	0.3	2.4	3.5
Salt	1.0	2.3	4.3	5.0	18.2	-9.8	5.1	0.1	3.5	1.2
Fruits	5.5	0.0	2.2	2.3	16.7	-11.8	6.8	0.1	2.3	2.5
Sugar	1.8	59.4	4.3	5.0	15.8	0.1	3.6	0.5	2.5	5.0
Tea and coffee	0.8	87.1	1.5	0.0	13.6	0.0	3.7	2.4	7.3	185.8
Non alcoholic drinks	1.2	0.0	6.2	6.1	10.6	0.5	2.4	-0.2	2.5	2.0
Alcoholic drinks	0.3	46.3	5.2	5.0	12.9	0.0	3.4	0.5	2.7	4.3
Housing	**17.9**	**27.5**	**3.8**	**3.5**	**6.9**	**1.6**	**1.2**	**0.5**	**2.7**	**5.1**
Rent	4.2	7.8	3.9	3.1	8.1	0.9	2.3	0.4	1.7	10.3
Maintenance and repairing	2.2	0.0	2.5	1.3	10.3	0.1	2.6	1.4	4.0	39.3
Energy products	4.7	97.0	4.6	4.8	10.1	0.2	2.1	0.5	3.1	4.4
Furniture and bedding	2.4	0.0	4.8	3.7	13.9	1.4	3.3	1.5	4.4	48.6
Household appliance	1.9	0.0	2.6	1.8	10.9	0.1	2.3	2.0	6.6	128.3
Dishes and cooking utensils	1.1	0.0	2.3	2.3	4.6	0.2	0.9	0.4	3.2	3.5
Furniture items	1.4	0.0	4.6	4.7	7.4	1.1	1.5	-0.4	2.7	2.8
Health	**10.5**	**52.9**	**4.7**	**5.1**	**8.5**	**0.4**	**2.0**	**-0.4**	**2.5**	**4.6**
Washing items	1.9	0.0	5.0	4.5	11.7	0.3	2.7	0.8	3.0	12.9
Maintenance products and detergent	1.5	0.0	5.8	6.2	19.4	-2.1	3.2	0.6	4.5	17.9
Hygiene service	1.6	0.0	5.1	5.0	13.6	1.0	3.1	1.4	4.7	46.8
Care and medicines	5.5	100.0	4.1	4.0	11.6	-1.8	3.2	0.3	2.7	1.9
Transport	**10.5**	**74.5**	**4.3**	**3.5**	**13.5**	**0.5**	**3.1**	**0.6**	**2.3**	**9.7**
Common transport	3.8	100.0	5.7	4.8	18.7	0.0	4.6	0.5	2.0	8.1
Individual transport	5.4	50.3	3.5	3.1	10.4	0.3	2.5	1.1	3.6	24.9
Telecommunication and mail	1.4	100.0	0.6	0.0	11.7	-9.9	5.1	0.2	4.4	9.4
Clothing	**11.7**	**0.0**	**5.5**	**5.3**	**8.8**	**1.8**	**1.9**	**0.1**	**1.8**	**6.5**
Clothes for men	2.0	0.0	6.1	6.1	11.7	1.3	2.7	0.1	2.0	5.3
Underwear for men	0.1	0.0	4.7	3.1	16.2	1.1	3.6	1.8	5.3	80.5
Clothes for women	1.9	0.0	4.5	3.8	9.7	0.6	2.3	0.5	2.2	7.3
Underwear for women	0.4	0.0	5.3	4.6	13.6	1.4	3.0	1.5	4.3	46.6
Clothes for children	2.2	0.0	5.4	4.8	11.4	1.7	2.8	0.6	2.2	10.4
Secondhand clothes	1.1	0.0	6.4	6.6	11.1	1.4	3.0	-0.1	1.5	10.6
Wearing accessories	0.4	0.0	4.2	3.8	8.7	0.2	2.0	0.3	2.3	4.1
Shoes	2.9	0.0	5.9	5.1	13.4	1.2	2.7	0.8	3.2	12.2
Fabric	0.3	0.0	4.6	2.5	17.7	0.4	4.2	1.6	4.9	61.5
Expenses related to clothing	0.3	0.0	4.2	3.9	10.9	-3.8	2.9	0.3	3.3	1.8
Services and other	**12.9**	**44.6**	**5.2**	**5.0**	**12.6**	**0.9**	**2.5**	**1.0**	**4.0**	**22.8**
Tobacco and cigarettes	2.9	100.0	4.2	5.8	9.5	0.0	3.6	-0.1	1.4	11.4
Leisure items	1.4	0.0	2.7	2.2	7.9	0.1	2.0	0.6	2.2	8.6
Spectacle, show, performance	0.3	0.0	7.8	6.7	23.2	-8.7	5.1	0.5	3.8	7.3
Drinks and meals	4.4	25.6	6.4	5.8	12.0	1.9	2.9	0.4	1.9	8.0
Education	3.0	57.0	6.3	3.9	23.8	0.0	6.0	1.7	5.0	72.6
Culture	0.8	0.0	3.9	3.4	9.0	-1.4	2.7	0.2	2.0	5.3

Sources: Tunisian authorities and IMF staff calculations.

Appendix Table I.3. CPI Components, Weights, and Main Descriptive Statistics (2000M1–06M12)

	Weights		Descriptive Stats							
	Total	Administered	Mean	Median	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Jarque-Bera
General index	**100.0**	**32.2**	**2.9**	**2.8**	**5.1**	**1.1**	**1.2**	**0.2**	**1.8**	**5.2**
Food	**36.5**	**22.3**	**3.4**	**3.8**	**7.6**	**-1.7**	**2.5**	**-0.2**	**1.9**	**4.7**
Cereal	5.4	70.7	2.9	2.4	7.0	0.1	2.5	0.5	1.5	11.0
Meat and poultry	7.0	0.0	4.8	3.6	16.3	-2.8	4.9	0.8	2.7	8.8
Fish	1.6	0.0	3.0	3.3	7.1	-1.7	2.2	-0.1	2.1	2.7
Eggs	1.0	0.0	1.2	-0.7	20.5	-15.2	10.2	0.3	1.9	5.5
Milk	3.8	44.7	1.6	1.3	3.7	0.1	1.1	0.5	1.9	7.4
Oil	1.8	37.0	9.0	6.8	32.9	-16.7	9.3	0.7	3.8	9.9
Vegetables	5.3	0.0	2.3	3.3	12.4	-10.4	5.9	-0.2	1.9	5.1
Salt	1.0	2.3	1.6	1.7	9.0	-3.9	2.8	0.3	2.9	1.5
Fruits	5.5	0.0	4.2	5.5	14.2	-12.2	6.6	-0.9	3.3	12.8
Sugar	1.8	59.4	1.4	0.7	6.9	-0.1	2.1	2.0	5.3	75.0
Tea and coffee	0.8	87.1	0.3	0.0	1.8	0.0	0.6	2.0	5.3	76.0
Non alcoholic drinks	1.2	0.0	3.1	2.8	8.9	0.0	1.9	0.7	2.8	6.9
Alcoholic drinks	0.3	46.3	3.1	3.0	6.9	0.0	2.2	0.3	2.0	4.3
Housing	**17.9**	**27.5**	**2.7**	**2.6**	**5.5**	**1.0**	**1.0**	**0.9**	**3.8**	**13.5**
Rent	4.2	7.8	3.6	3.3	7.6	2.4	1.1	1.1	4.0	21.6
Maintenance and repairing	2.2	0.0	2.3	1.6	8.9	0.2	2.0	2.2	7.0	125.0
Energy products	4.7	97.0	3.9	3.8	12.0	0.0	2.8	1.0	4.1	19.3
Furniture and bedding	2.4	0.0	1.7	1.5	4.2	0.6	0.8	1.0	3.3	14.0
Household appliance	1.9	0.0	0.5	0.4	1.2	-0.6	0.4	0.0	3.6	1.1
Dishes and cooking utensils	1.1	0.0	1.3	1.4	3.1	0.0	0.6	0.4	3.7	4.5
Furniture items	1.4	0.0	2.2	2.0	5.9	0.5	1.2	1.0	3.6	14.4
Health	**10.5**	**52.9**	**2.7**	**1.9**	**5.8**	**1.1**	**1.6**	**0.8**	**2.0**	**12.6**
Washing items	1.9	0.0	2.2	2.1	4.4	0.1	1.2	-0.1	1.9	4.4
Maintenance products and detergent	1.5	0.0	2.7	2.4	6.5	0.7	1.4	1.2	3.9	23.3
Hygiene service	1.6	0.0	3.3	2.9	6.7	1.3	1.2	0.7	3.2	7.8
Care and medicines	5.5	100.0	2.7	1.6	7.2	0.2	2.3	0.9	2.2	13.1
Transport	**10.5**	**74.5**	**3.5**	**3.3**	**7.5**	**0.4**	**1.7**	**0.4**	**2.4**	**3.7**
Common transport	3.8	100.0	3.1	2.9	8.4	-0.1	2.6	0.5	2.1	6.8
Individual transport	5.4	50.3	5.0	4.1	12.8	0.0	3.6	0.4	2.1	5.3
Telecommunication and mail	1.4	100.0	-1.9	0.0	0.7	-12.3	4.0	-2.0	5.2	73.4
Clothing	**11.7**	**0.0**	**1.7**	**1.8**	**4.1**	**-0.9**	**1.1**	**-0.1**	**2.1**	**2.7**
Clothes for men	2.0	0.0	1.1	1.1	5.5	-3.6	1.7	0.1	3.2	0.5
Underwear for men	0.1	0.0	2.1	1.6	8.6	-2.2	2.5	0.9	3.5	13.5
Clothes for women	1.9	0.0	1.6	1.5	7.0	-4.1	1.8	-0.1	4.1	4.5
Underwear for women	0.4	0.0	1.7	1.9	5.0	-2.9	1.4	-0.5	4.1	7.8
Clothes for children	2.2	0.0	1.9	1.9	5.4	-2.1	1.5	0.1	3.6	1.3
Secondhand clothes	1.1	0.0	2.8	2.2	7.2	0.1	2.1	0.8	2.6	9.6
Wearing accessories	0.4	0.0	1.5	1.5	3.6	-0.2	1.0	0.4	2.4	3.9
Shoes	2.9	0.0	1.8	1.8	6.6	-2.8	2.1	0.4	2.5	2.5
Fabric	0.3	0.0	0.8	0.5	4.1	-1.8	1.4	1.1	3.8	19.2
Expenses related to clothing	0.3	0.0	1.7	1.4	3.4	0.2	0.9	0.4	1.8	6.8
Services and other	**12.9**	**44.6**	**2.1**	**2.1**	**3.2**	**0.8**	**0.5**	**-0.4**	**3.5**	**3.0**
Tobacco and cigarettes	2.9	100.0	1.8	0.0	5.0	0.0	2.2	0.4	1.3	12.7
Leisure items	1.4	0.0	0.1	0.4	1.3	-2.0	0.8	-1.2	3.3	19.1
Spectacle, show, performance	0.3	0.0	1.4	0.9	4.6	0.0	1.2	0.9	2.7	11.9
Drinks and meals	4.4	25.6	2.7	2.6	5.6	0.7	1.1	0.8	3.7	10.3
Education	3.0	57.0	2.2	2.6	4.0	-0.5	1.3	-0.4	2.0	5.7
Culture	0.8	0.0	2.5	2.2	7.2	0.0	1.9	1.0	3.2	12.9

Sources: Tunisian authorities; and IMF staff calculations.

Appendix Table I.4. Average Contribution to Overall Inflation by Different Components

(In percent)

	Weights		Average Contribution		
	Total	Administered	1991M1–2006M12	1991M1–99M12	2000M1–06M12
General index	**100.0**	**32.2**	**100.0**	**100.0**	**100.0**
Food	**36.5**	**22.3**	**38.3**	**36.0**	**43.1**
Cereal	5.4	70.7	7.2	8.1	5.3
Meat and poultry	7.0	0.0	8.9	7.7	11.5
Fish	1.6	0.0	2.2	2.5	1.7
Eggs	1.0	0.0	0.4	0.4	0.4
Milk	3.8	44.7	3.7	4.5	2.1
Oil	1.8	37.0	2.5	1.0	5.6
Vegetables	5.3	0.0	3.9	3.8	4.2
Salt	1.0	2.3	0.8	0.9	0.5
Fruits	5.5	0.0	4.4	2.7	8.0
Sugar	1.8	59.4	1.4	1.7	0.9
Tea and coffee	0.8	87.1	0.2	0.3	0.1
Non alcoholic drinks	1.2	0.0	1.5	1.6	1.3
Alcoholic drinks	0.3	46.3	0.4	0.4	0.4
Housing	**17.9**	**27.5**	**15.5**	**14.9**	**16.9**
Rent	4.2	7.8	4.1	3.6	5.2
Maintenance and repairing	2.2	0.0	1.4	1.2	1.8
Energy products	4.7	97.0	5.3	4.8	6.4
Furniture and bedding	2.4	0.0	2.2	2.6	1.5
Household appliance	1.9	0.0	0.8	1.0	0.3
Dishes and cooking utensils	1.1	0.0	0.5	0.5	0.5
Furniture items	1.4	0.0	1.3	1.4	1.1
Health	**10.5**	**52.9**	**10.5**	**10.8**	**9.9**
Washing items	1.9	0.0	1.9	2.1	1.4
Maintenance products and detergent	1.5	0.0	1.7	1.9	1.4
Hygiene service	1.6	0.0	1.8	1.8	1.8
Care and medicines	5.5	100.0	5.0	4.9	5.1
Transport	**10.5**	**74.5**	**10.9**	**9.9**	**13.0**
Common transport	3.8	100.0	4.5	4.7	4.0
Individual transport	5.4	50.3	5.8	4.1	9.4
Telecommunication and mail	1.4	100.0	-0.2	0.2	-0.9
Clothing	**11.7**	**0.0**	**11.7**	**14.0**	**7.0**
Clothes for men	2.0	0.0	2.1	2.7	0.8
Underwear for men	0.1	0.0	0.1	0.1	0.1
Clothes for women	1.9	0.0	1.6	1.9	1.0
Underwear for women	0.4	0.0	0.4	0.5	0.2
Clothes for children	2.2	0.0	2.2	2.6	1.4
Secondhand clothes	1.1	0.0	1.4	1.6	1.1
Wearing accessories	0.4	0.0	0.3	0.4	0.2
Shoes	2.9	0.0	3.1	3.8	1.8
Fabric	0.3	0.0	0.2	0.3	0.1
Expenses related to clothing	0.3	0.0	0.3	0.3	0.2
Services and other	**12.9**	**44.6**	**12.9**	**14.7**	**9.3**
Tobacco and cigarettes	2.9	100.0	2.4	2.7	1.9
Leisure items	1.4	0.0	0.6	0.9	0.1
Spectacle, show, performance	0.3	0.0	0.4	0.5	0.1
Drinks and meals	4.4	25.6	5.5	6.2	4.2
Education	3.0	57.0	3.5	4.1	2.3
Culture	0.8	0.0	0.7	0.7	0.7

Sources: Tunisian authorities, and IMF staff calculations.

Appendix Table I.5. Individual Leading Indicators for Inflation (Bivariate Regressions)

	General index				CPI excluding 5 most volatile items				CPI excluding 10 most volatile items			
Lead months	3	6	9	12	3	6	9	12	3	6	9	12
NEER	-0.080094 (0.0119)	-0.096355 (0.0615)				-0.052032 (0.1295)						
Tunis Stock market index	0.017572 (0.0978)			0.029989 (0.026)					0.013741 (0.0418)			
M2	0.076117 (0.0956)	0.093901 (0.096)	0.095779 (0.0646)	0.06815 (0.0823)								
M4	0.140073 (0.0217)	0.132803 0.0431	0.141537 (0.0251)	0.138452 (0.0546)	0.069861 (0.0371)	0.08704 (0.0741)	0.142902 (0.009)	0.123154 (0.0749)			0.11867 (0.0119)	0.108107 0.0632
Credit to economy	0.155597 (0.0526)											
Producer price index	0.157223 (0.0925)				0.126773 (0.0325)		0.177857 (0.0652)	0.254476 0.0663	0.100489 (0.0882)		0.163799 (0.0336)	0.207033 (0.0905)
Industrial Production Index		0.03848 (0.067)				0.023519 (0.1168)				0.028975 (0.0371)		

Source: IMF staff estimates.

Note. We run bivariate regressions of h-period inflation on a large number of potential leading indicators. We estimate un equation with three lags for the dependend variable (inflation) and a potential leading indicator for inflation. Only significant variables in one of the models are reported here. P-values are in parentheses.

Appendix Table I.6. Composite Leading Indicators for Inflation (Multivariate Regressions) 1/

	General index				CPI excluding 5 most volatile items				CPI excluding 10 most volatile items			
Lead months	h=3	h=6	h=9	h=12	h=3	h=6	h=9	h=12	h=3	h=6	h=9	h=12
Constant	0.63	1.74	2.61	4.42	0.22	0.44	0.50	1.13	0.25	0.42	0.50	1.07
	(0.0309)	(0)	(0)	(0)	(0.1421)	(0.0287)	(0.0485)	(0.0001)	(0.1714)	(0.0739)	(0.0719)	(0.0008)
π_t^{12}	1.63	1.25	0.70	-0.46	0.77	0.67	0.26	-0.21	0.70	0.59	0.26	-0.35
	(0)	(0.0001)	(0.0139)	(0.0257)	(0)	(0.0008)	(0.2707)	(0.3545)	(0)	(0.002)	(0.2513)	(0.1131)
π_{t-1}^{12}	-1.03	-1.20	-1.18	-0.41	0.00	-0.07	0.04	0.32	0.05	-0.01	0.04	0.49
	(0)	(0)	(0)	(0.0444)	(0.9944)	(0.6743)	(0.8559)	(0.1365)	(0.7885)	(0.9575)	(0.8479)	(0.0208)
NEER	-0.04	-0.05	-0.06	-0.11	-0.04	-0.10	-0.11	-0.13	-0.02	-0.07	-0.07	-0.09
	(0.0982)	(0.1978)	(0.0529)	(0.0001)	(0.0291)	(0)	(0.0001)	(0)	(0.3062)	(0.0064)	(0.0106)	(0.0055)
M4	0.05	0.07	0.11	0.04	0.03	0.02	0.07	0.05	0.02	0.02	0.07	0.04
	(0.0935)	(0.0807)	(0.0021)	(0.2074)	(0.1662)	(0.3033)	(0.0073)	(0.1438)	(0.1848)	(0.3054)	(0.0058)	(0.1856)
Producer price index	0.02	0.11	0.21	0.08	0.03	0.06	0.18	0.18	0.03	0.07	0.15	0.14
	(0.7552)	(0.1648)	(0.0083)	(0.2516)	(0.3785)	(0.1639)	(0.0002)	(0.0004)	(0.1639)	(0.0554)	(0.002)	(0.0082)
Adjusted R-squared	0.61	0.28	0.47	0.65	0.69	0.56	0.48	0.31	0.62	0.42	0.31	0.17
Included observations	105	102	99	96	105	102	99	96	105	102	99	96
RMSE	0.72	1.01	0.83	0.64	0.5	0.5	0.45	0.46	0.37	0.43	0.41	0.21

Source: IMF staff estimates.

1/ White Heteroskedasticity-Consistent Standard Errors & Covariance. P-values are in parentheses.

II. THE EXCHANGE RATE PASS-THROUGH IN TUNISIA[1]

A. Introduction

1. **Given the high degree of openness of the Tunisian economy, the exchange rate channel of monetary policy plays a central role in the transmission mechanism of monetary policy,** especially as Tunisia moves closer to a free floating exchange rate system and adopts an inflation targeting framework. Understanding the transmission channels of monetary policy is key for the conduct of an efficient monetary policy. This is particularly true within an inflation targeting framework where policy relies heavily on model-based forecasting of inflation for monetary policy formulation.

2. **Therefore, it is crucial to assess the exchange rate pass-through given that the degree of consumer price responsiveness to exchange rate changes has important implications for monetary policy.** Exchange rate pass-through to domestic prices measures the extent to which fluctuations in the nominal exchange rate affect consumer prices through the changes in the prices of imported goods.[2] Consumer prices are affected directly by the change in the prices of imported finished and intermediate goods, but also indirectly through the effects of exchange rate movements on aggregate demand. For instance, an exchange rate depreciation affects net exports, which in turn influences domestic prices through aggregate demand, putting upward pressure on domestic prices. However, consumer prices may not be very responsive to the exchange rate when variations in imports costs are absorbed by intermediaries in the distribution channel. Therefore, the degree of exchange rate pass-through will depend, among other things, on the competitive nature of the domestic market for importable goods and pricing-to-market behavior.

3. **The aim of this paper is to econometrically estimate the degree of exchange rate pass-through in Tunisia.** The methodology relies on time series and panel estimation methods, using both monthly and quarterly data for a basket of 43 consumption products during 1995–2006.

4. **The paper is organized as follows.** Section B discusses the determinants of exchange rate pass-through and summarizes the results of some empirical studies on developing and emerging economies. Section C describes the fluctuations in the nominal effective exchange rate in Tunisia, the underlying factors, and the resulting effects on inflation. Section D presents the econometric methodology and the estimation results. Section E concludes and offers some policy recommendations.

---

[1] Prepared by Abdelhak Senhadji and Kangni Kpodar.

[2] Exchange rate pass-through has been used interchangeably to mean exchange rate pass-through to import prices and to consumer prices. In this paper, exchange rate pass-through will refer to the later unless otherwise indicated.

B. Theory and Empirical Studies on Exchange Rate Pass-Through

Theoretical background[3]

5. **The law of one price posits that the exchange rate pass-through to import prices (in domestic currency) is always immediate and complete.** However, absolute purchasing power parity (PPP) theory has been generally rejected statistically . Several theoretical arguments have been put forward to explain partial or incomplete exchange rate pass-through.

6. **The "pricing-to-market" theory argues that pass-through could be incomplete because foreign producers may accept lower profit margins to preserve their market share.** Although an exchange rate depreciation increases the cost of imported intermediate goods, imperfectly competitive firms may choose to totally or partially absorb the increase in production cost, reducing the pass-through to consumer prices. Moreover, distribution services provide some insulation for consumer prices of traded goods, as they dilute the import content of final consumption goods and as distributors may actively adjust profit margins to absorb currency fluctuations (Campas and Goldberg, 2006).

7. **Taylor (2000) argues that the pass-through rises with the level of inflation.** In a model of firm behavior based on staggered price setting and monopolistic competition, the author shows that a credible low inflation regime leads to a lower pass-through, or conversely the persistence of high inflation is positively correlated with the level of pass-through. The underlining assumption is that improved credibility and effectiveness of monetary policy in maintaining a low inflation rate will lower the pass-through as firms would expect a change in costs or prices to be less persistent. Consequently, they are less prone to change prices in response to a given exchange rate shock because they expect the monetary authority to act strongly to stabilize domestic inflation.

8. **Other factors such as nominal rigidities and slow adjustment of good prices could make domestic prices less responsive to exchange rate movements.** In the later case, the pass-through is delayed but might not be incomplete.

9. **Whether partial or complete, exchange rate pass-through is an important factor that determines the effectiveness of exchange rate adjustments in achieving or maintaining a sustainable external balance.** Expenditure switching policies aimed at addressing balance of payments difficulties rely on the role of the exchange rate in shifting consumer purchase to domestically produced goods from imported goods. If the degree of pass-through is high, the required exchange rate adjustement needed to correct an unsustainable current account position will be relatively small. The converse holds if the pass-through is low.

---

[3] In this section, exchange rate pass-through refers to exchange rate pass-through to import prices, which in turn impact consumer prices.

10. **Under a flexible exchange rate regime, a low exchange rate pass-through could help stabilize both output and inflation.** Devereux (2001) shows that in a small open economy with high exchange rate pass-through, there is a significant trade-off between output volatility and inflation volatility. But with limited or delayed pass-through, this trade-off is much less pronounced. A flexible exchange rate can deliver both lower output variance and lower inflation. Therefore, a low exchange rate pass-through could provide greater flexibility in the pursuit of an independent monetary policy and make it easier to implement inflation targeting (Choudhri and Hakura, 2001).

A brief empirical literature review

11. **The relationship between exchange rates and good prices has been extensively analyzed**. But only a few studies pertain to developing and emerging countries. These studies can be split into two broad categories: country-specific and cross-country studies.

12. **Most country-specific studies find low exchange rate pass-through.** Among these, Mwase (2006) uses structural vector autoregression models to provide evidence of an incomplete pass-through to inflation in Tanzania. Furthermore, the degree of pass-through has decreased over time, possibly because of declining inflation since the mid-1990s, higher productivity, and increased competition. However, Khundrakpam (2007) does not find evidence of a decline in exchange rate pass-trough to domestic prices in India, despite a lower inflationary environment. Bhundia (2002) also finds a low pass-through in South Africa as exchange rate fluctuations are absorbed at the intermediate stage of production.

13. **Cross-country studies provide a strong support for Taylor (2000)'s theory.** Choudhri and Hakura (2001) find that the pass-through is positively correlated with the inflation rate across a large sample of countries.[4] The authors use quarterly data over the period 1979–2000 and provide evidence for incomplete pass-through in most countries, including Tunisia. In line with this study, Devereux and Yetman (2003) show that estimated pass-through are positively associated with average inflation rates, but the relationship is nonlinear. Pass-through rises with inflation but at a declining rate. While Choudhri and Hakura's (2001) results suggest that inflation dominates other macroeconomic variables in explaining cross-country differences in pass-through, Goldfajn and Werlang (2000) find, in a sample of 71 countries including Tunisia, that the real exchange rate misalignment is the most important variable explaining exchange rate pass-through for emerging countries, whereas it is the initial inflation for developed countries. Aside from inflation and exchange rate misalignment, factors such as per capita income, tariffs, wages, long-term exchange rate variability, and trade openness have been also evidenced as determinants of exchange rate pass-through (see Goldfajn and Werlang, 2000; Frankel, Parsley, and Wei, 2005).

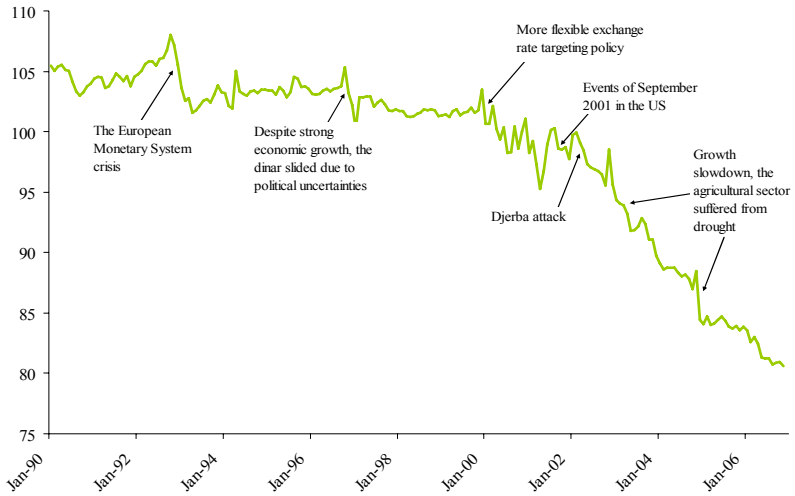
[4] Mumtaz, Oomen, and Wang (2006) reach similar conclusions using data on UK industries.

C. Exchange Rate and Inflation in Tunisia

14. **During the 1990s, Tunisia adopted a real effective exchange rate (REER) targeting policy aimed at preserving the competitiveness of the country.** This policy, consisting in adjusting periodically the nominal exchange rate so as to maintain the REER constant, proved to be fairly successful as the country avoided the pitfalls of its REER targeting, which generally are a persistently high inflation and an exchange rate misalignment.[5] The absence of significant shocks, combined with a prudent macroeconomic policy mix and price rigidities, were the main factors underlying the relatively low inflation (5.1 percent on average over 1990–99) and the absence of significant exchange rate misalignment the country had experienced while pursuing the REER targeting policy.

15. **Since 2000, the central bank has implemented a more flexible exchange rate policy and adopted broad money as nominal anchor.** The nominal effective exchange rate has depreciated by about 20 percent since 2000 (Figure II.1). Two factors help explain the gradual depreciation of the dinar. First, the depreciation reflects a series of negative shocks (a series of severe droughts and the events of September 2001 in the U.S. and 2002 in Djerba). Second, the euro has strengthen rapidly against the dollar, which contributed to a depreciation of the Tunisian currency, since the euro is estimated to account for at least two-thirds of the dinar's currency basket. Although the dinar has depreciated significantly, the latest estimates suggest that the REER appears in line with economics fundamentals. At the same time, inflation has been subdued, averaging only 2.7 percent over 2000–06 compared with 5.1 percent during the 1990s.

Figure II.1. Trends in Nominal Effective Exchange Rate (NEER), 1990–2006



Source: IMF (2006).

[5] Fanizza D, N. Laframboise, E. Martin, R. Sab, and I. Karpowicz, 2002, "*Tunisia's Experience with Real Exchange Rate Targeting and the Transition to a Flexible Exchange Rate Regime*," IMF Working Paper No. WP/02/190.

D. The Degree of Exchange Rate Pass-Through to Consumer Prices

The methodology

16. The following log-linear regression specification captures the dynamic relationship between the consumer price inflation (henceforth, referenced simply as *inflation*) and year-on-year changes in the nominal effective exchange rate while controlling for other factors affecting inflation:

$$\Delta cpi_t = \alpha + \sum_{j=1}^{M} \beta_j \Delta cpi_{t-j} + \sum_{k=0}^{N} \gamma_k \Delta neer_{t-k} + AX_t + \varepsilon_t \quad (1)$$

Where the index *t* refers to time, cpi_t is the log of the aggregate consumer price index, $neer_t$ is the log of the nominal effective exchange rate defined as foreign currencies per unit of domestic currency (therefore an increase in the index implies a nominal appreciation), X_t is a vector of control variables—including the log of the monetary aggregate M4 and a set of dummy variables capturing the changes in administered food and fuel prices—and ε_t is the error term.

17. An important variable that is missing in the set of control variables X_t is the import price index, which is not available on a monthly basis but is available on a quarterly basis. Given the relatively small number of quarterly observations in the sample, the model with import prices as explanatory variable is estimated using panel data for the 43 groups of goods and services included in the Tunisian CPI. The corresponding model for panel data can be written as:

$$\Delta cpi_{it} = \alpha + \sum_{j=1}^{M} \beta_j \Delta cpi_{it-j} + \sum_{k=0}^{N} \gamma_k \Delta neer_{t-k} + AY_{it} + u_i + \varepsilon_{it} \quad (2)$$

Where indexes *i* and *t* refer to the cross-sectional and time dimensions, cpi_{it} is the log of the consumer price index for group of goods and services i at time t, $neer_t$ has the same definition as in equation (1). Note however that this variable has no cross-sectional index *i* because it only varies across time given that the effective exchange rate is the same for all groups of goods and services. Y_{it} is a vector of control variables— including the log of the monetary aggregate M4 and import price PM_t—, u_i is a good-specific fixed effect, and ε_{it} is the error term. The dummy variables for administered prices are not included given that the model includes fixed effects.

18. Equations (1) and (2) were estimated by Ordinary Least Square (OLS) using respectively monthly and quarterly data from 1995 to 2006.[6] To avoid the problem of spurious regression, all the variables entering equations (1) and (2) have been tested for unit roots. Augmented Dickey-Fuller and Phillips-Perron unit-root tests, performed on all variables entering the two equations, suggest that all variables are I(1) in levels, and therefore I(0) in first difference (Appendix II.1). In other words, all variables entering equations (1) and (2) are stationary in first differences. To eliminate seasonality the Δ operator refers to year-on-year percentage changes.

19. The appropriate lag structure (i.e., the parameters *M* and *N*) is determined by using the Bayesian Information Criteria (BIC). The lags structures of inflation and nominal effective exchange rate year-on-year changes capture inflation persistence and allow for a parsimonious but still flexible parameterization of the dynamics of the pass-through of exchange rate fluctuations to consumer prices. The main variable of interest is the long-run exchange rate pass-through given by the formula below:

$$LR = \frac{-\sum_{j=0}^{N} \gamma_j}{1 - \sum_{i=1}^{M} \beta_i} \qquad (3)$$

In addition to the long-run exchange rate pass-through, impulse response functions will also be used to trace out the detailed dynamics of the exchange rate pass-through.

Estimation results

Results from times-series data

20. **Overall, the model has a good fit** (Table II.1 and Figure II.2). All variables have the expected sign and are generally statistically significant at least at the 5 percent significant level. As shown by the adjusted R^2, the model has a good fit, explaining more than 90 percent of the variability in the aggregate inflation rate. The Durbin-Watson test suggests that the absence of serially correlated errors could not be rejected, as a result, standard errors are corrected for autocorrelation as well as heteroscedasticity.

21. **Estimates of the long-run pass-through imply a 10 percent nominal depreciation of the dinar that translates into an increase in inflation in the 0.7–0.9 percentage point range, depending on model specification.** Equation (1) in Table II.1 shows that a 10 percent depreciation in the NEER will increase inflation by 0.65 percentage points. Although the estimated pass-through is significant, it could be even higher if the price of some imported goods was liberalized as administrated prices account for almost a third of the

[6] The sample period was determined by data availability. It also corresponds to the post-stabilization period during which inflation averaged about 3.8 percent.

CPI basket. Equations (2)−(4) control for the administered nature of the price of food and fuel by including two dummy variables. Food and fuel are two important goods with heavy import content that are included in the CPI basket. The food price (respectively fuel prices) dummy variable takes 1 when food prices (respectively fuel prices) increase and 0 otherwise. When controlling for administrated food prices (equation (2), the degree of pass-through increases significantly (by about 15 percent). The pass-through strengthens even more when the dummy variable for fuel prices is included (equation (3)), jumping from 0.65 to 0.89 (a 37 percent increase). Including both dummy variables raises the degree of pass-through to 0.93, which implies a 43 percent increase. As a result, a 10 percent depreciation in NEER is associated with a 0.93 percentage point increase in inflation (equation (4)). Interestingly, this long-run pass-through estimate for Tunisia is very close to the one found in Choudhri and Hakura (2001) using quarterly data over 1979–2000. According to the authors' findings, the long run pass-through was 0.09 after 4 quarters and 0.10 after 20 quarters.

22. **Monetary aggregate M4 is significantly correlated with inflation.** The coefficient associated with M4 is positive and significant at 5 percent in all regressions, suggesting that a monetary contraction reduces inflation. Section D of the previous chapter explains why in Tunisia M4 captures the stance of monetary policy better than M3.

23. **The impulse response function shows that the pass-through process takes about 18 months to complete** (Figure II.3), reflecting the persistence of the inflation process. This is consistent with the results from other studies.

Results from panel data

24. **This sub-section compares the results from the time-series model with that of the panel data model.** As discussed earlier, the time-series model does not include import prices as they are not available on a monthly basis. Import prices are an important explanatory variable in the sense that it controls for the dollar price of imports (i.e., imports prices in foreign currency) when included with the nominal effective exchange rate in the estimated equation. Therefore, equation (2) includes quarterly import prices and is estimated using panel data to increase the sample size. To facilitate the comparison between the time-series model (which excludes import prices) and panel data model, the latter will be estimated with and without import prices. In equation (2) the dependent variable is the price index of each of the 43 CPI components at the two-digit level of desegregation. All variables are measured at the quarterly frequency.

25. **Once import prices are controlled for, the exchange rate pass-through strengthens to about 1.2 percentage point increase in inflation for a 10 percent increase in the NEER.** The estimation results of the panel model are given in Table II.2. The first column provides the estimation results of equation (2) without import prices and without fixed effects. The estimate of long-run pass-though is 0.072, very close to the benchmark estimate of 0.065 from the time-series model. The estimate of pass-through remains almost unchanged when using fixed effects (0.068). The long-run exchange rate pass-through

strengthens when the import index is included—0.118 when equation (2) is estimated with fixed effects and 0.11 when estimated without fixed effects. After controlling for changes in import prices, a 10 percent depreciation in the NEER will translate into an increase in inflation of 1.2 percentage points according to the model without fixed effects and 1.1 percentage points according to the model with fixed effects. The fact that the panel model yields similar results with and without fixed effects implies that it captures relatively well the heterogeneity in inflation dynamic across the 43 categories of products.

26. **The estimates from panel data are relatively close to those of the time-series model.** It is worth noting that the time-series model without the dummy variables for the administered prices of food and fuel products is closely related to the panel data model without the import price index while the time-series model with these dummy variables corresponds to the panel data model with the import price index among its explanatory variables. The reason is that the dummy variables for food and fuel products capture indirectly the increase in the import prices of these two categories of goods.[7] Similarly, controlling for the dollar price of imports indirectly controls for administered prices of imported goods. The estimation results tend to confirm this interpretation. The time-series model without the administered price dummy variables yields an estimate of the exchange rate pass-through of 0.065, which is very close to the estimate of 0.068 from the panel data model without the import price index. Similarly, the time series-model with the dummy variables for the administered price of food and fuel products yields an estimate of the exchange rate pass-though of 0.093 relatively close to the estimate of 0.11 from the panel data model with the import price index. It is important to stress, however, that both the use of dummy variables for the administered price of food and fuel products in the time-series model and the inclusion of the import price index in the panel model do not control fully for the effect of a large share of administered prices in the CPI, especially for the administered price of goods and services domestically produced.

27. **The effect of the monetary aggregate M4 on inflation also strengthened and is even more powerful than that of exchange rate**. A 10 percent increase in M4 leads to an increase in inflation in the 1.1–1.8 percentage point range, which is higher than that of the effect of the nominal effective exchange rate.

28. **Given the large size and the parsimony of the panel data model, it fits the data quite well.** The model explains about 50 percent of inflation variations across the 43 groups of goods and services during 1995 to 2006.

29. **However, the results presented so far may be subject to endogeneity bias as the causality may also run from inflation to the exchange rate.** To deal with endogeneity

[7] By definition, the dummy variables for food and fuel products take one when their prices increase and zero otherwise. Given that these increases happen when the import price of these goods increases, these dummy variables indirectly capture increases in their import prices.

issues, a Generalized-Method of-Moments (GMM) dynamic panel estimator is used. It also addresses potential biases associated with measurement errors and omitted variables.[8]

30. **The results obtained using the System-GMM estimator are consistent with the previous findings**. A 10 percent depreciation of the dinar would increase inflation by about 0.9 percentage points (Table 3, column 1). As expected, the pass-through strengthens to 1.2 percentage points after controlling for changes in import prices. The results are statistically meaningful as the Hansen over-identification test and the second-order autocorrelation test validate the use of the system GMM estimator and the suitability of lagged variables as instruments.

E. Conclusions and Policy Recommendations

31. **This paper analyzes the exchange rate pass-though, an important channel of transmission of monetary policy.** Time series and panel data models provide close estimates of exchange rate pass-through:

- Combining the results from the time-series and panel models imply that the estimate of exchange rate pass-through is in the 0.09–0.12 range, depending on the estimation method and model specification. This implies that a 10 percent nominal depreciation of the dinar would induce an increase in inflation in the 0.9–1.2 percentage points.

- The estimation results also show that the liberalization of administered prices would increase the degree of pass-through, although it is difficult to precisely quantify by how much.

- The relatively low degree of pass-through in Tunisia is consistent with the finding in previous studies showing that the degree of pass-through in low inflation countries tend to be lower than that in high inflation countries.[9]

---

[8] The GMM dynamic panel estimator offers two different approaches. The first-differenced GMM, developed by Arellano and Bond (1991), takes the first difference of the equation to remove time invariant specific effects and instruments the right-hand side variables with appropriate lags of the specified variables in levels. However, the efficiency of this approach is weakened when lagged values in levels are weak instruments for the first differenced variables. Arellano and Bover (1995) and subsequently Blundell and Bond (1998) suggested the System GMM estimator which combines the first-differenced GMM with an additional set of equations in levels where the right-hand side variables are instrumented with suitable lagged first differences. Evidence from Monte Carlo simulations showed that the System GMM estimator performs better than the first-differenced GMM estimator.

[9] Choudhri and Hakura (2001) find that the average degree of pass-through for 37 countries with low inflation is 0.16. In that study, Tunisia's degree of pass-through for the period 1979–2000 was 0.10 compared to 0.29 for Morocco.

- The estimation results also point to the fact that the actual monetary policy framework, based on broad money targeting, combined with a supporting exchange rate policy can be used effectively to control inflation, including imported inflation.

- While parsimonious, the time-series and panel data models capture fairly well the inflation dynamics in Tunisia, and provide estimates of pass-though that are consistent with the estimates found in the literature. Furthermore, the estimation method controls for potential endogeneity of the explanatory variables, the problem of omitted variables, and measurement errors.

The main policy recommendations are the following:

- It is worth stressing that these econometric estimates of the degree of pass-through as well as the results of the previous chapter are conditional on the current monetary policy framework. It is quite likely that the transmission mechanism will evolve as the monetary framework moves gradually toward inflation targeting. Therefore, it is critical to build the research capacity of the BCT to continue to develop and update its analytical toolkit for the transmission mechanism of monetary policy and for inflation forecasting.

- For monetary policy to effectively control inflation, the share of administered prices, which stands currently at 32 percent, should be reduced significantly through price liberalization to avoid inconsistencies between monetary and fiscal policies. Price liberalization is also consistent with the absence of fiscal dominance required under the inflation targeting framework. While price liberalization may induce a short-term increase in inflation, which would require a monetary policy response, monetary policy will become more flexible and more efficient. Furthermore, price deregulation would dampen fiscal pressures, which should translate into a less inflationary fiscal position.

- While the pass-through is relatively low, it remains significant. Thus, the econometric study highlights the importance of closely coordinating monetary and exchange rate policies. This is particularly important in view of Tunisia's transition toward inflation targeting.

- As the Tunisian economy continues its integration to the world economy through the liberalization of the capital account, the relatively low pass-through implies that an orderly move to a free-floating exchange rate should improve Tunisia's inflation-output variability trade-off as research shows.[10] In other words, as the capital account opens up the adoption of a more flexible exchange rate could help Tunisia stabilize both output and inflation.

[10] See Devereux (2001).

Table II.1. Exchange Rate Pass-Through into Consumer Prices, 1995–2006

	(1)	(2)	(3)	(4)
Δcpi (t-1)	1.214	1.251	1.213	1.246
	(13.52)***	(14.02)***	(13.55)***	(14.08)***
Δcpi (t-2)	-0.176	-0.227	-0.180	-0.224
	(1.34)	(1.69)*	(1.36)	(1.67)*
Δcpi (t-3)	-0.156	-0.135	-0.144	-0.129
	(2.00)**	(1.74)*	(1.82)*	(1.63)
Δneer (t)	0.046	0.042	0.044	0.040
	(2.59)**	(2.28)**	(2.43)**	(2.18)**
Δneer (t-1)	-0.053	-0.050	-0.054	-0.050
	(3.11)***	(2.83)***	(3.18)***	(2.90)***
Food price dummy		0.002		0.002
		(1.94)*		(1.66)*
Fuel price dummy			0.001	0.001
			(1.54)	(1.23)
Δm4 (t)	0.019	0.019	0.020	0.019
	(2.42)**	(2.37)**	(2.49)**	(2.43)**
Constant	0.002	0.001	0.002	0.001
	(1.01)	(0.75)	(0.95)	(0.73)
Observations	130	130	130	130
Adjusted R^2	0.92	0.92	0.92	0.92
Inflation persistence	0.883	0.889	0.888	0.893
Total effect of NEER change	-0.008	-0.008	-0.010	-0.010
Long run pass-through	0.065	0.075	0.089	0.093
Long run impact of M4	0.165	0.170	0.177	0.179
Root Mean Square Error	0.003	0.003	0.003	0.003
Durbin-Watson test (prob)	0.70	0.53	0.84	0.69

Notes: Robust t statistics in parentheses. Standard errors are corrected for heteroscedasticity and first-order autocorrelation. Inflation persistence is the sum of the coefficients for the three first lags of the CPI. The total effect of NEER change is the sum of the coefficients for the contemporaneous exchange rate and its first lag. A time trend is included in the model. *** significant at 1 percent, ** significant at 5 percent, * significant at 10 percent.

Table II.2. Exchange Rate Pass-Through into Consumer Prices:
A Panel Approach, 1995–2006

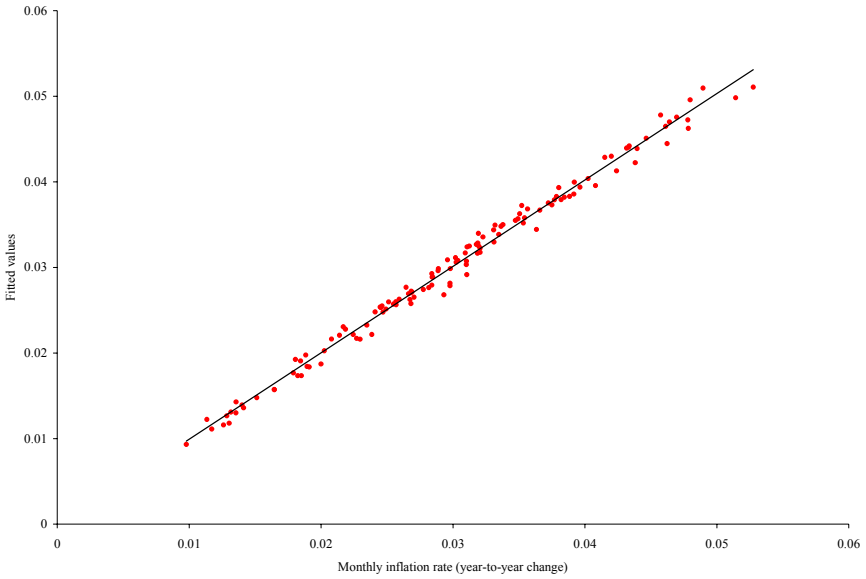
	Without fixed effects		With fixed effects	
	(1)	(2)	(3)	(4)
Δcpi (t-1)	0.692	0.658	0.657	0.621
	(9.41)***	(8.50)***	(28.64)***	(25.58)***
Δcpi (t-2)	0.085	0.108	0.077	0.099
	(1.41)	(1.75)*	(2.80)***	(3.48)***
Δcpi (t-3)	-0.151	-0.172	-0.180	-0.200
	(3.52)***	(3.82)***	(7.92)***	(8.46)***
Δneer (t)	0.078	0.083	0.076	0.081
	(1.93)*	(1.97)**	(1.85)*	(1.92)*
Δneer (t-1)	-0.105	-0.131	-0.106	-0.133
	(2.64)***	(2.86)***	(2.59)***	(2.71)***
Δm4 (t)	0.048	0.044	0.058	0.051
	(2.94)***	(1.28)	(3.25)***	(1.56)
Δpm (t)		0.006		0.010
		(0.55)		(0.80)
Constant	0.007	0.012	0.010	0.015
	(1.88)*	(1.39)	(3.08)***	(2.29)**
Observations	1849	1720	1849	1720
R^2	0.50	0.46	0.46	0.42
Inflation persistence	0.626	0.594	0.554	0.521
Total effect of NEER change	-0.027	-0.048	-0.030	-0.053
Long run pass-through	0.072	0.118	0.068	0.110
Long run impact of M4	0.129	0.109	0.131	0.107

Notes: T statistics in parentheses. Inflation persistence is the sum of the coefficients for the three first lags of the CPI. The total effect of NEER change is the sum of the coefficients for the contemporaneous exchange rate and its first lag. A time trend is included in the model. *** significant at 1 percent, ** significant at 5 percent, * significant at 10 percent.

Table II.3. Exchange Rate Pass-Through into Consumer Prices:
An Instrumental Variable Approach, 1995–2006

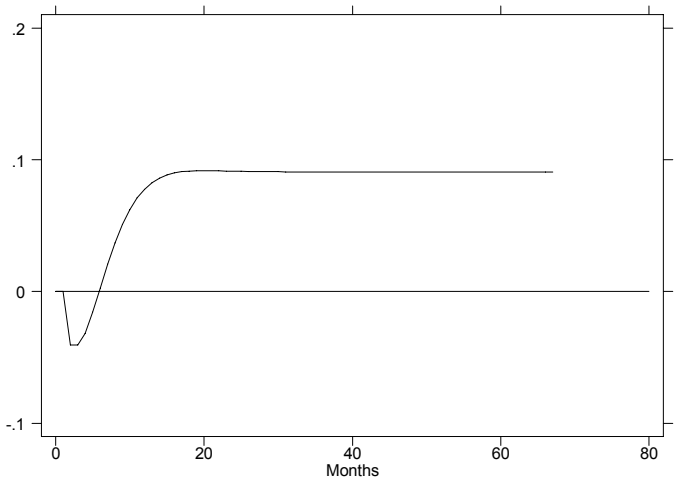
	System-GMM	
	(1)	(2)
Δcpi (t-1)	0.672	0.653
	(3.31)***	(3.47)***
Δcpi (t-2)	0.175	0.161
	(0.76)	(0.74)
Δcpi (t-3)	-0.261	-0.251
	(2.00)**	(1.52)
Δneer (t)	0.076	0.081
	(1.38)	(1.51)
Δneer (t-1)	-0.112	-0.131
	(2.58)***	(3.27)***
Δm4 (t)	0.054	0.052
	(2.57)**	(2.00)**
Δpm (t)		0.008
		(0.49)
Constant	0.010	0.013
	(1.70)*	(1.30)
Observations	1849	1720
Inflation persistence	0.586	0.563
Total effect of NEER change	-0.036	-0.051
Long run pass-through	0.087	0.12
Long run impact of M4	-0.131	-0.118
Hansen test	0.39	0.43
AR(2)	0.76	0.88

Figure II.2. Quality of the Prediction: Actual Versus Fitted Inflation Rate



Source: Authors' calculations.

Figure II.3. An Impulse Response Function of a 1 percent Depreciation in the NEER



Source: Authors' calculations.

REFERENCES

Arellano, M., and S. Bond, 1991, "Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations," *Review of Economic Studies*, Vol. 58, pp. 277–97.

Arellano, M., and O. Bover, 1995, "Another Look at the Instrumental Variable Estimation of Error-Components Models," *Journal of Econometrics*, Vol. 68, pp. 29–52.

Bhundia, A., 2002, "An Empirical Investigation of Exchange Rate Pass-Through in South Africa," IMF Working Paper No. 02/165.

Blundell, R., and S. Bond, 1998, "Initial Conditions and Moment Restrictions in Dynamic Panel Data Models," *Journal of Econometrics*, Vol. 87, No. 1, pp. 115–43.

Campa, J. M., and L. Goldberg, 2006, "Pass Through of Exchange Rates to Consumption Prices: What Has Changed and Why?" Federal Reserve Bank of New York Staff Report No. 261.

Choudhri, E. U., and D. Hakura, 2001, "Exchange Rate Pass-Through to Domestic Prices: Does the Inflationary Environment Matter?" IMF Working Paper No. 01/194.

Devereux, M., 2001, "Monetary Policy, Exchange Rate Flexibility, and Exchange Rate Pass-through," In *Revisiting the Case for Flexible Exchange Rates*, Bank of Canada, pp. 47–82.

Devereux, M., and J. Yetman, 2003, "Price-Setting and Exchange Rate Pass-Through: Theory and Evidence," In *Price adjustment and monetary policy*, Bank of Canada, pp. 347–71.

Fanizza, D., N. Laframboise, E. Martin, R. Sab, and I. Karpowicz, 2002, "Tunisia's Experience with Real Exchange Rate Targeting and the Transition to a Flexible Exchange Rate Regime," IMF Working Paper No. 01/194.

Frankel, J. A., D. Parsley and S. Wei, 2005, "Slow Pass-through Around the World: A New Import for Developing Countries?" NBER Working Papers 11199.

Goldfajn, I., and S. Werlang, 2000, "The Pass-through from Depreciation to Inflation: A Panel Study," Department of Economics PUC-Rio, Brazil.

Khundrakpam, J. K., 2007, "Economic Reforms and Exchange Rate Pass-Through to Domestic Prices in India," BIS Working Papers No. 225.

Mumtaz, H., O. Oomen, and J. Wang, 2006, "Exchange Rate Pass-Through into UK Import Prices," Bank of England Working Paper No. 312.

Mwase, N., 2006, "An Empirical Investigation of the Exchange Rate Pass-Through to Inflation in Tanzania," IMF Working Papers 06/150.

Taylor, J., 2000, "Low Inflation, Pass Through and Pricing Power of Firms," *European Economic Review*, Vol. 44, pp. 1389–408.

Appendix II.1. Stationarity Tests with Monthly Data

1. Augmented Dickey-Fuller Test

	Level	First difference	1 percent critical value	Number of lags*	Result
CPI					
Without trend	-3.33	-7.37	-3.48	2	I(1)
With trend	-2.77	-8.15	-4.01		
NEER					
Without trend	2.53	-6.76	-3.48	5	I(1)
With trend	0.07	-7.60	-4.01		
M4					
Without trend	-0.55	-8.56	-3.50	1	I(1)
With trend	-2.28	-8.54	-4.03		
PM					
Without trend	0.61	-4.73	-3.57	2	I(1)
With trend	-0.41	-5.00	-4.13		

*Based on the BIC criterion.

2. Phillips-Perron Test

	Level	First difference	1 percent critical value	Number of lags*	Result
CPI					
Without trend	-3.55	-9.51	-3.48	2	I(0) without trend,
With trend	-2.57	-9.95	-4.01		and I(1) with trend
NEER					
Without trend	1.86	-17.74	-3.48	5	I(1)
With trend	-0.53	-18.59	-4.01		
M4					
Without trend	-0.64	-12.07	-3.50	1	I(1)
With trend	-2.38	-12.03	-4.03		
PM					
Without trend	0.37	-10.17	-3.56	2	I(1)
With trend	-0.98	-10.32	-4.12		

*Based on the BIC criterion.

Appendix II.2. Summary Statistics and Data Sources

Variable* (year to year change)	Obs	Mean	Std. Dev.	Min	Max
CPI	144	0.033	0.013	0.011	0.066
NEER	143	-0.019	0.023	-0.079	0.033
M4	130	0.082	0.034	0.016	0.197
PM (Quarterly)	44	0.026	0.067	-0.195	0.144

*Monthly data unless indicated.

Variable	Definition	Source
CPI	Consumer price index	Tunisian Authorities
M4	Monetary aggregate M4	
PM	Industrial production index	
NEER	Nominal effective exchange rate expressed as the weighted average of the dinar exchange rate vis-à-vis the currencies of the main partners. An increase in the nominal effective exchange rate implies an appreciation of the dinar.	International Monetary Fund