The Stylized Facts of Greek Inflation: New Evidence

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Introduction

The study of inflation is of fundamental importance since it can have far-reaching implications for the economy both in terms of economic efficiency and wealth distribution. Moreover, this is reflected in the mandate of many monetary authorities to maintain price stability. Such central bank institutions pay special attention to the development of tools enabling them to better understand and monitor the properties of inflation dynamics.

This study adds to the relevant literature by attempting to explain inflation dynamics in Greece over the period 1981−2009. To this end, it uses three distinct approaches: the inflation persistent hypothesis, the identification of spillover effects among various sectors in the economy through a Vector Autoregressive Model (VAR) and the investigation of the domestic Balassa-Samuelson effect. The VAR model assumes a recursive relation among the disturbances of the variables as they are described by the sectoral price indices.

A better understanding of the inflation process is important from a broader policy standpoint. In particular, for policy makers it is useful to know the degree to which inflation has been driven by common factors that affect all sectors in the economy as opposed to sector-specific factors related to domestic aggregate demand-supply conditions. Inflation is also costly. High inflation results in a redistribution of wealth from those with fixed incomes to those with flexible incomes (from lenders to borrowers) and reduces real returns on savings and investments. The characteristics driving inflation dynamics vary depending either on the time horizon or on the characteristics of a particular sector in the economy. Over the short-run, the structure of the consumption basket plays an important role for inflation. Thus, for given price shocks, inflation is expected to be higher in countries with higher energy and food price shares in the consumer basket. Over the long-run, factors, such as convergence of price levels across countries become a more important driving force.

At the same time, inflation in Greece, a variable that crucially characterizes the international competitiveness of the economy, is one of the most important topics in the ‘policy dialogue’ between country authorities and the IMF. This is especially the case for an economy with weak international competitiveness as well as weak institutions and capacity, making it particularly difficult to control inflation. Although the Greek economy has enjoyed, over the last 10 years solid economic growth, and after a period of low inflationary pressures, the economy is now experiencing inflationary pressures caused by higher commodity prices, which are mainly due to the lack of strong competitive forces in particular sectors in the economy as well as to high indirect taxes imposed through the agreement of the country with the IMF and the EU supportive lending programme. Moreover, Greece cannot sustain inflation above its euro partners, since its international trade volume is heavily affected by inflation differentials between the country and those partners.

This study is organized as follows. Chapter 1 describes the main features of the inflation process in Greece in terms of inflation persistence. The analysis is implemented through both aggregate and disaggregated price indices. The empirical findings are expected to be of important relevance for policymaking. Chapter 2 reports spillover effects among the most important categories, across sectors, for inflation dynamics in the Greek economy. Finally, Chapter 3 presents the results of the analysis of the domestic Balassa-Samuelson effect that relates inflation differentials with respect to productivity differentials

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Chapter 1: Inflation persistence

Definitions and Literature

In the literature of inflation, as inflation persistence is defined the tendency of inflation to converge at a slow pace to the central bank's inflation goal, following various other shocks. This property of inflation seems important for many reasons, including forecasting. The phenomenon of inflation persistence assists the analysis of cross-country inflation differentials by helping distinguish between structural and shock-induced inflation differentials. Monetary authorities can entirely control the inflation rate in the long-run, implementing the proper monetary policy, but they can not entirely direct the short–run inflation rate towards the desirable inflation target, as miscellaneous macroeconomic shocks will temporarily incite the inflation divergence from the inflation target of the central bank. Thereby, it is highly important for the monetary authorities to know the speed with which the inflation rate returns to its long-run equilibrium level after a disturbance as an inflation process that exhibits persistence analogous to that of a random walk calls for more cautious monetary policy than if persistence were low.

Recent developments in the literature of inflation persistence argue that this phenomenon should not be necessarily considered as a time-invariant phenomenon. The literature argues that changes in the level of credibility of the central bank's commitment to attain its policy objectives should have an effect on the relative importance of forward-looking and backward-looking terms in inflation models, such as the New-Keynesian-Phillips-Curve (Taylor, 1998; Sargent, 1999). Cogley and Sargent (2001) add to the discussion by claiming that such changes in inflation persistence are capable of explaining policy mistakes leading to high inflation rates, while the concept of persistence is important per se since it determines how important is the approach of the New Keynesian Phillips curve for explaining price stickiness. The implications of such models have to do with the impact on the level of inflation persistence. Without the hypothesis of persistence, then time-invariance implies that high inflation persistence trends need not be an intrinsic feature of economies (Bordo and Schwartz, 1999; Goodfriend and King, 2001; Erceg and Levin, 2003; Benati, 2003).

Many researchers have concluded that high inflation persistence is a “stylized fact” in industrial economies, while the alternative viewpoint is that the degree of inflation persistence is not an inherent structural characteristic of industrial economies, but rather varies with the stability and transparency of the monetary policy regime. Barsky (1987) finds that U.S. inflation persistence was very high from 1960-1979, but was much lower from 1947-1959. Evans and Wachtel (1993) estimate a Markov-switching model for U.S. inflation and find that the series was generated by a low-persistence regime over the periods 1953-1967 and 1983-1993, but it was generated by a random-walk process over the period 1968-1982.

Moreover, the literature has attempted to measure empirically the characteristics of inflation persistence time-invariance. Studies by Barsky (1987), Evans and Wachtel (1993), Brainard and Perry (2000), Taylor (2000), Ravenna (2000), Kim et al. (2001), Cogley and Sargent (2001), Stock (2001), Benati (2003), Levin and Piger (2004), O’Reilly and Whelan (2004) and Pivetta and Reis (2007) provide mixed results on inflation persistence, raising a debate about the constancy of inflation persistence along with changes in the monetary policy environment. Moreover, Pivetta and Reis (2007) and Stock and Watson (2007) show that inflation persistence in the U.S. has not changed over the last 30 to 40 years.

Levin and Piger (2004) estimate an AutoRegressive (AR) model allowing for structural breaks in the mean of the inflation process and re-estimate the model without considering any shifts in the central bank’s inflation target, i.e. without any structural break. They do that because they argue that a chunk of the inflation persistence may be related to ignoring structural breaks in the mean inflation, which may reflect changes in central banks’ inflation target over time. In other words, the restriction of not allowing structural breaks may result in misleadingly high inflation parameter estimates. Without accounting for possible breaks they find a persistence parameter for the U.S. GDP deflator spanning the period 1984-2003. Once they allow for a structural break, the persistence parameter falls sharply. Bilke (2004**)** makes use of disaggregated CPI time series to analyze the dynamics of French inflation. He first estimates inflation persistence by using the erratic hypothesis of a stable mean and finds that inflation persistence is strong, being unable to reject the hypothesis of a unit root for overall CPI, industrial goods and services. However, when allowing for a structural break in the mid-eighties, inflation persistence dramatically decreases in every case.

Dossche and Everaert (2005) argue that in most of the empirical studies inflation is found to exhibit high to very high persistence over the post WWII period, possibly because these studies ignore the fact that the data generating process of inflation consists of a number of distinct components, each of them exhibiting its own level of persistence. They follow a structural time series approach to model the data generating process of inflation in the euro area and the U.S., using quarterly data from 1970 to 2003 and display that if these components are taken into account, intrinsic inflation persistence is found to be lower than the persistence of a random walk.

Clark (2003) and Cecchetti and Debelle (2004) suggest that the use of disaggregate price series can strengthen the diagnosis of overall inflation persistence. Lunnemann and Matha (2004) using disaggregate price indices from the Harmonized Index of Consumer Prices (HICP), study the degree of inflation persistence in the EU15, the euro area and its member states and show that most disaggregate inflation series such as, durables and services are characterized by a low to moderate degree of persistence. In addition, they find support for a positive aggregation effect, i.e. aggregate inflation exhibits a larger degree of inflation persistence than the weighted average of the disaggregate series, thus the aggregate inflation series, which is characterized by persistence close to that of a random walk process, is primarily contingent on the properties of its most persistent components.

Hondroyiannis and Lazaretou (2004) study the inflation persistence in Greece spanning the period 1975 to 2003 and employ two empirical methodologies to estimate inflation persistence, namely a univariate autoregressive (AR) modelling and a second generation random coefficient modelling. They find that inflation persistence was high during the inflationary period and the first six years of the disinflationary period, while it started to decline after 1997, when inflationary expectations seem to have been stabilised, and thus, monetary policy was effective at reducing inflation.

This first part of the study contributes to the existing empirical literature of inflation persistence by providing results on the level of inflation persistence for the Greek economy using alternative inflation series (GDP deflator, CPI deflator and Core inflation). The literature makes use of the most elementary approach for defining core inflation and which consists of excluding certain categories of prices from the overall inflation rate, such as food and energy. The concept of core inflation is based on the theory of the cost of living index. There are differences with the harmonized index of consumer prices that usually assesses inflation trends in the euro area and is mostly related to a concept known as final household monetary consumption. The HICP excludes certain categories of prices, such as the cost of owner-occupied housing. The monetary authorities in Europe make an extensive use of the core inflation since it is a well-defined concept of monetary inflation. After all, the principal goal of the European Central Bank is monetary inflation targeting and this definition of inflation serves better that goal (Howitt, 1997; Bernanke et al., 1999). However, our analysis makes use of all available inflation indices for the simple reason that inflation is not uniquely determined solely by the monetary authorities but by the joint workings of the monetary authorities, the fiscal authorities and the private sector.

The Methodology of Testing for Inflation Persistence

In terms of the empirical analysis, the first part of this study makes use of measures of persistence that are based on univariate models of inflation. In this manner, the persistence results relate to the absorption of a shock. This type of analysis has the merit of providing valid results on persistence and constitutes a useful initial step in the collection of information on the persistence of inflation series. Accordingly, we will make use of two different measures of inflation persistence on the basis of such univariate models, namely, the sum of the autoregressive coefficients and the half-life indicator. The measures of persistence are based on the following equation:

$$\pi_t = \mu_0 + \mu_1 D_t + \rho\, \pi_{t-1} + \sum_{i=1}^{p} \alpha_i \Delta\pi_{t-i} + \varepsilon_t$$

where, D_t allows for the presence of a structural break in the intercept to avoid spurious overestimation of the level of inflation persistence (Perron, 1989; Levin and Piger, 2004). This break takes the form of a permanent shift; thus, assuming a break occurs at date T, then $D_t = 0$ for $t<T$ and 1 for $t \geq T$. In such a dynamic equation, a shift in the mean can be considered as a permanent shock to the inflation process. The total impact of the change in the mean yields:

$$\sum_{j=0}^{\infty}(\partial\pi_{t+j}/\partial x_t) = \partial x_t/(1-\rho)$$

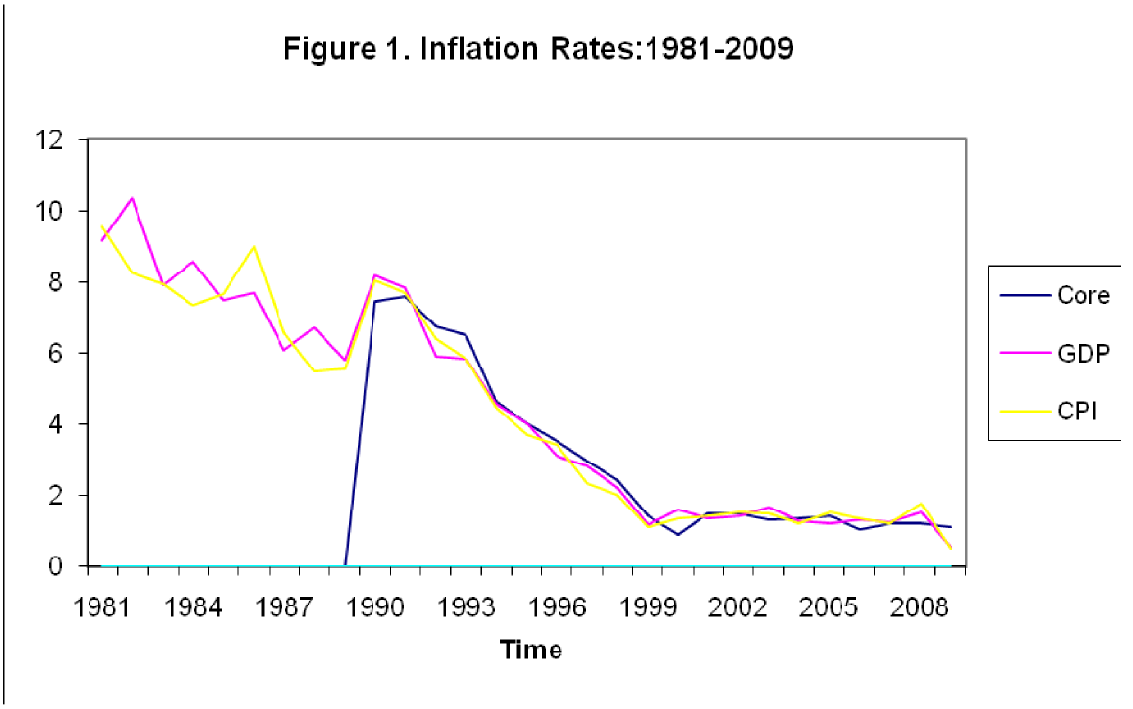
where, ∂x_t is the permanent shock to the process. In other words, it is the shift in the mean as measured by the dummy D_t in the equation. The above equation implies the swiftness of the movement to reach the new mean, following the presence of a break, is a function of ρ, which represents the degree of inflation persistence. This characteristic of the autoregressive process points a sluggish adjustment to permanent shifts in the monetary goal (Erceg and Levin, 2000). It also yields that intercept breaks are considered as adequate tools to model temporary trending patterns observed in some inflation series, i.e. periods of deflation.

Therefore, the first measure of inflation persistence is the parameter ρ. This parameter also corresponds to the sum of the coefficients of the lagged dependent variables, when the equation is given in an autoregressive (AR) form. This parameter also captures important characteristics of the impulse response function. This function characterizes the pattern of absorption of shocks hitting the inflation process over time. In other words, the cumulative effect of a shock on inflation is given by 1/(1-ρ). Therefore, the higher the value of ρ, the higher the cumulative impact of the shock on inflation. If the economy displays various different patterns of shocks dynamics, then the economy could absorb shocks more rapidly. In such a case, the measure of persistence is referred to the relative size of the overall effect of a shock on inflation, rather than providing information on the relative timing of shock absorption.

The Pattern of Greek Inflation

Figure 1 depicts the three inflation series over the period 1981 through 2009, except for the definition of the core inflation where the sample spans the period 1989-2009. The figure presents the various phases of the Greek inflation experience for the period post of 1980. As it can be observed, the three inflation rates tend to move roughly in a parallel fashion. In addition, the inflation series experienced the following two distinct phases: prior and post the early 90s period.

In particular, in the 1990s, special attention was paid towards controlling the large fiscal deficit and lowering the high inflation rate as serious efforts to meet the criteria of the new European currency programme were made. In particular, spanning 1991-1994, a tight monetary policy, a tight fiscal policy and a slower devaluation of the exchange rate were the key factors that helped Greece to exhibit for the first time after approximately 20 years single-digit inflation rates. At that point, experts believed that private-sector confidence in the government's anti-inflation policies had been boosted, making future reductions in the inflation rate very likely. This convergence programme for meeting the Maastricht criteria continued until 1998 when the drachma joined the European Exchange Rate Mechanism (ERM). Thereafter, inflation remained at very low levels until 2009.



Empirical Analysis

Data

The empirical analysis uses data on three different measures of consumer prices; that is the Consumer Price Index (CPI), the GDP Index and the Core inflation Index with 1995 as the base year (1995=100). Data covers the period 1981 to 2009 except for CPI and the GDP deflator and the period 1989 to 2009 for the Core inflation. In addition, disaggregated (sectoral) data was also obtained for the CPI and Core inflation measures. All indices are Laspeyres chained. Data comes from the Datastream database and is based on a quarterly basis. Finally, we employ the RATS 6.1 software to serve the goals of our empirical analysis.

Unit root testing (identifying a break)

Since Perron (1989), there has been widespread interest in allowing for structural breaks when carrying out unit root tests (Zivot-Andrews, 1992; Banerjee et al., 1992; Perron, 1997). This complicates unit root testing because: (i) ignoring breaks greatly reduces the power of standard unit root tests, (ii) the break date may or may not been known *a priori* and 'data mining' to choose the break date biases test results, and (iii) some unit root test procedures (Zivot-Andrews, 1992) allow for a break only under the alternative hypothesis. That is, they test the null hypothesis of a unit root with no break against the alternative hypothesis of (mean or trend) stationarity with a break. This approach proves invalid for analysts who are interested in questions about the presence unit roots as well as structural breaks. Thus, it is natural to extend unit root tests to allow for breaks. This approach to unit root testing has the major advantage of allowing for a break(s) under both the null and the alternative hypotheses. Turning now to a case where the break date is unknown, we consider a unit root test criterion for identifying the unknown break date. This is the min-τ criterion proposed by Zivot and Andrews (1992). We investigate the one-break procedure here. The one-break min-τ LM unit root test statistics is denoted as follows:

$$\tau(\lambda_{AL}) = \inf_{\lambda \in \Lambda} \tau_{\alpha AL}(\lambda)$$

where $\tau_{\alpha\,AL}\tau$ is the t statistics on x_{t-1} in equation:

$$\Delta y = \mu + \alpha^{AL} x_{t-1} + d_1^{AL} D(DUM)_{\lambda T} + d_2^{AL}(DUM)_{\lambda T} + e_t^{AL}$$

where y is the price index, Δy denotes inflation rates, T is the total number of observations and λ is the portion of the sample before the break occurs. The dummy variable $DUM_{\lambda T}$ is zero for the first λT observations and one thereafter, while a 'spike' dummy $D(DUM_{\lambda T})$ is also used to capture the effect of a level shift break under the null hypothesis of a unit root. The coefficient d_1 determines the size of the level shift. The coefficient d_2 determines the size of the spike dummy shift and Λ is the 15% trimmed sample. The min-τ criterion is used to estimate the break date, λ_{AL}. Table 1 reports the results of the structural break analysis for the case of intercept showing the date of a significant break for Greece. The test estimates that most of the breaks occur around the period 1992-1993. In other words, an 'EMU effect' or better a 'Maastricht Treaty effect' seems to be in place. Thus, we reject the null hypothesis of the unit root for inflation, i.e. inflations are I(0) processes, at the 1% significance level. Although the dates vary accordingly to the definition of inflation, they point out that these breaks typically occur at the beginning of 90s and appear to correspond with the sign of the Maastricht Treaty in 1992. In other words, an EMU effect seems to play a substantial role here. Finally, the fact that a break point was identified will help us to avoid overestimation of the persistence parameter ρ in the event that such a break is present in the variables under investigation. In addition, the results deliver a clear finding of a change in inflation, which is mostly related to a major change in the conduct of monetary policy environment, a result supported by other studies for other economies (Stock and Watson, 2007).

Table 1. Structural breaks in the intercept

Inflation Measure	τ-statistic	Break Date	Conclusion at 5%
GDP inflation	-5.35	1993:2	I(0)
CPI inflation	-5.17	1993:2	I(0)
Core inflation	-4.86	1992:4	I(0)

Notes: Critical value of the τ statistic: -6.67.

Table 2 reports the annualized changes in the mean of inflation implied by the structural break in the intercept. Across all definitions, the break in the intercept implies a decline in inflation trends.

Table 2. Change in mean inflation after structural break in intercept

Inflation Measure	Change in Mean
GDP inflation	-11.24
CPI inflation	-14.38
Core Inflation	-12.41

Next, we run a joint test for the presence of a break in all the parameters of the equation of persistence, conditional on the presence of a break in the intercept. In other words, this is an overall stability test. Thus, we perform a Chow test for the presence of a structural break in all of the AR coefficients, where the parameters are allowed to break at the same date as the intercept (as above). The reported results in Table 3 support the absence for any need to worry about any instability.

Table 3. Structural break in all AR parameters conditional on a break in intercept

Inflation Measure	Date
GDP inflation	1993:2
CPI inflation	1993:2
Core Inflation	1992:3

Notes: Similar to Table 1.

A common approach in the empirical literature (Batini, 2002; Levin and Piger, 2004; Hondroyiannis and Lazaretou, 2004) for modeling inflation persistence is to estimate the univariate autoregressive (AR) model defined above. Let the persistence parameter $\rho = \sum_{i=1}^{p} a_i$ measuring the slugginess with which the inflation series responds to shocks. An AR(p) process can be written as $y_t(1 - \alpha_1 L - a_2 L^2 \cdots - a_p L^p) = u_t$ and is stationary if all the p roots of the polynomial equation $\Phi(L)=0$ are greater than one in absolute value and $\sum_{i=1}^{p} a_i < 1$. Therefore, inflation persistence can be measured as the sum of the estimated AR coefficients (Andrews and Chen, 1994; Fuhrer and Moore, 1995; Pivetta and Reis, 2004). Thus if $\sum_{i=1}^{p} a_i \approx 1$, then inflation persistence almost follows a random walk and the best way for the monetary authorities to herald the next inflation rate is to observe the current. Note that ρ=1, if the data-generating process has a unit root, whereas | ρ | < 1, if the data-generating process is stationary. To obtain an estimate of p, an AR lag order must be chosen for each inflation series. With a maximum lag length of p=4 and based on the Akaike Information Criterion, we choose a particular lag order for each series that is reported in Table 4. The results are reported under both the absence of a break date and with the presence of a break date.

Table 4. AIC Lag Order Selection

GDP Inflation		CPI Inflation		Core Inflation	
No break	With break	No break	With break	No break	With break
3	4	3	3	4	4

Notes: The heading 'No Break' indicates that no structural breaks were included in the model specification; that is AR lag order selection was performed using the entire sample. The heading 'With Break' refers to the lag order chosen using a model that allowed for structural change at the least squares estimate of the break date listed in Table 3.

It is well known that the least squares estimator of the persistence parameter ρ is biased downward, particularly as p approaches unity. Furthermore, confidence intervals constructed based on an asymptotic normal distribution for $\hat{\rho}$ do not have correct coverage. To remedy these deficiencies, we construct confidence intervals using the grid bootstrap procedure of Hansen (1999), which simulates the sampling distribution of the t-statistic over a grid of possible true values for p in order to construct confidence intervals with correct coverage. In the bootstrap procedure we allow for heteroscedasticity by constructing se($\hat{\rho}$) using the White (1980) heteroscedasticity-consistent standard error estimator and scaling each of the parametrically generated bootstrap residuals by the actual residual obtained from least-squares estimation conditional on each value of p in the grid. Table 5 reports percentiles of the bootstrap distribution for p.

Table 5. Estimates of persistence, excluding structural breaks

GDP inflation			CPI Inflation			Core CPI inflation		
5	50	95	5	50	95	5	50	95
0.38	0.68	0.84	0.44	0.72	0.89	0.47	0.76	0.93

Notes: Values shown are the 5th, 50th and 95th percentiles for ρ from the Hansen (1999) grid bootstrap procedure applied to the AR model using the lag order. The grid search was conducted over a range of four standard deviations above and below the least-squares estimate in increments of 0.01. 1000 bootstrap simulations were performed for each value on the grid.

The results from Table 5 point out that the core inflation is the definition with the highest persistence, which could point to lower persistence of the excluded components (energy and food items) of the GDP deflator and CPI indices. The GDP deflator shows the lowest persistence levels.

In order to determine the number of breaks in our sample, we also test for the case of multiple breaks using the test proposed by Bai and Perron (1998). We first look at the max FT(M, q) test to see if at least a structural break exists. In this study, the maximum number of breaks (*l*) is chosen to be 4. The estimated supF(*l)* tests are:

GDP deflator: supF(1) = 39.87, supF(2) = 48.73, supF(3) = 57.65 and supF(4) = 65.68

CPI = supF(1) = 44.15, supF(2) = 45.92, supF(3) = 52.38 and supF(4) = 62.81

Core = supF(1) = 46.14, supF(2) = 49.12, supF(3) = 49.98 and supF(4) = 53.44

Only at the first lag the estimates are all significant at the 1% level*;* thus, the series appears to have one structural break. Based on the above statistics we can spot the break point between 1992 and 1993. For each inflation series for which a structural break in intercept was found to be statistically significant at the 5%, we perform a Chow test for the presence of a structural break in the persistence parameter at the same break date (Table 6).

Table 6. Testing the stability of the persistence parameter (conditional on a structural break in the intercept)

	GDP Inflation	CPI Inflation	Core Inflation
Chow test [p-value]	1993:2 F=4.87[0.00]	1993:2 F=4.95[0.00]	1992:4 F=5.48[0.00]

Notes: For each inflation series for which a structural break in intercept was identified at the 5% significance level, this table reports the F-statistics along with the p-values for the Wald test of the null hypothesis that the persistence parameter ρ does not exhibit a structural break for the intercept.

The Chow test results show that the F values along with their corresponding p-values do exceed their critical values at the 1% significance level. These results imply that there is a structural change before and after the period of the Maastricht Treaty.

Following a similar approach, Table 7 reports the results of a Chow test for the stability of all of the AR coefficients, where the parameters are allowed to break at the same date as the intercept.

Table 7. Testing the stability of all AR parameters (conditional on a structural break in the intercept)

	GDP Inflation	CPI Inflation	Core Inflation
Chow test[p-value]	1993:2 F= 4.55[0.00]	1993:2 F=4.87[0.00]	1992:4 F=5.23[0.00]

Notes: Similar to Table 6.

Once again, the results imply that there is a structural change before and after the period of the Maastricht Treaty.

Half-Life Indicator Results

Due to the potential limitations of the parameter ρ, we also make use of the half-life indicator (HL). This indicator measures the number of periods during which a temporary shock displays more than half of its initial impact to the process of inflation. In this manner, this indicator is related to the impulse response function of the inflation process. This indicator implies that the test is based on whether the impulse response function is below 0.5 at a particular period after the shock. If this is the case, then we should continue decrementing this number of the period until we find the point at which the impulse response function is above 0.5. This indicator provides useful complementary information to the results provided by the ρ parameter. Thus, combining the two indicators we can reduce the risk of foregoing entirely all relevant information pertaining to the differences in the shape of the impulse response function. The results are reported in Table 8.

Table 8. Half-life results

GDP Inflation			CPI Inflation			Core Inflation		
5	50	95	5	50	95	5	50	95
1	1	1	1	1	3	1	1	6

Notes : Results in the table report the number of periods in quarters during which an initial shock to the inflation process continues to display at least 0.5 of its initial impact.

The results of Table 8 are very close to those reported above, indicating the low persistence in all three definitions. These results imply that the impact of a shock to the inflation process is already halved within the first quarter (when the value of the indicator is equal to one), indicating that inflation remained at low levels throughout the entire period under examination. Moreover, the half-live indicator confirms the above results that persistence is lower for the GDP deflator case and the highest in the case of the Core inflation.

Inflation persistence without a break

This part reports results for the persistence parameter ρ. These results are reported in Table 9. The results are reported for various inflation categories. In addition, this present study makes use of aggregated as well as disaggregated inflation time series. Clark (2003) and Cecchetti and

Debelle (2004) argue that making use of sectoral inflation series strengthens the diagnosis of overall inflation. A study by Lunnemann and Matha (2004) also reach similar conclusions, however all of those studies do not include any break in their analysis. By contrast, this is a novelty in our work. Table 9 also reports the lag order used in each case based on the Akaike Information criterion.

Table 9. Estimates of the ρ parameter (without a break)

Inflation Measure	ρ estimates	Akaike determined lags
CPI ITEMS		
All items	0.56	3
Electricity	0.45	4
Electricity + gas + other fuels	0.48	2
Electricity + gas + solid fuels + heat energy	0.46	2
Energy	0.47	3
Energy + seasonal food	0.35	3
Energy + unprocessed food	0.36	4
Fresh food and vegetables	0.32	4
Fuels	0.58	3
Goods-food-non alcoholics	0.42	3
Services	0.35	4
Unprocessed food	0.39	4
Unprocessed food & energy	0.42	4
Accompany services	0.52	3
Actual rentals for housing	0.56	2
Alcoholic beverages	0.37	2
Alcoholic beverages + tobacco	0.38	3
Audio visual, photographic, info processing equipment	0.69	3
Beer	0.37	4
Books	0.35	4

Table 9 continued

Bread and cereals	0.38	3
Canteens	0.39	3
Carpets + other floor coverings	0.38	2
Catering services	0.44	2
Cleaning repair + hire of clothing	0.41	2
Clothing	0.46	3
Clothing and footwear	0.47	4
Clothing materials	0.45	4
Coffee, tea, cocoa	0.43	4
Combined passenger transport	0.58	3
Communications	0.40	4
Cultural services	0.67	4
Domestic + household services	0.39	2
Durables for recreation + musical instruments	0.62	3
Education	0.67	3
Education + health + social protection	0.52	3
Electrical appliances + products for personal care	0.62	3
Equipment for reception, recording of sound + pictures	0.59	3
Equipment for sport, camping + open air recreation	0.50	4
Food + non alcoholic beverages	0.37	4
Food + alcohol + tobacco	0.36	4

Table 9 continued

Footwear, including repair	0.47	4
Fruits	0.39	2
Fuel + lubricants for personal transportation equipment	0.65	3
Furnishing + household equipment + routine house maintenance	0.64	4
Furniture + furnishing + carpets + other floor coverings	0.62	3
Furniture + furnishing	0.53	3
Games, toys, hobbies	0.30	3
Gardens, plants, flowers	0.32	2
Garments	0.35	4
Gas	0.57	4
Glassware, tableware, household utensils	0.50	4
Goods, services for routine household maintenance	0.52	3
Goods – services	0.63	3
Hairdressing salons + personal grooming establishments	0.45	4
Health	0.48	4
Household appliances	0.64	3
Household appliances + electrical	0.63	3
Household textiles	0.31	3
Housing, water, electricity, gas, other fuels	0.42	2

Table 9 continued

Industrial goods	0.55	4
Information processing equipment	0.44	4
Insurance	0.49	3
Insurance connected with the dwelling	0.41	3
Insurance connected with the transportation	0.50	4
Jewelers, clocks, watches	0.45	4
Liquid fuels	0.48	4
Liquid fuels + lubricants for Personal transportation equipment	0.67	3
Maintenance repair of personal + transportation equipment	0.58	2
Maintenance + repair of the dwelling	0.47	2
Materials for maintenance + repair of the dwelling	0.68	3
Meat	0.39	4
Medical products, appliances, equipment	0.68	4
Milk, cheese, eggs	0.40	4
Mineral water, soft drinks, fruits, vegetables juices	0.41	3
Miscellaneous printed materials, stationery + drawing materials	0.59	3
Miscellaneous goods and services	0.42	3
Motor cars	0.65	3

Table 9 continued

Motor cycles and bicycles	0.65	3
Newspapers and periodicals	0.39	2
Newspapers, books, stationery	0.38	3
Non alcoholic beverages	0.43	4
Non durable household goods	0.36	3
Non energy industrial goods	0.45	3
Non energy industrial goods (durables)	0.64	3
Non energy industrial goods (non durables)	0.45	3
Non energy industrial goods (semi durables)	0.43	4
Oil and fats	0.49	2
Operation of personal transport equipment	0.57	4
Other medical products, therapeutic appliances and equipment	0.58	3
Other articles of clothing and clothing accessories	0.41	3
Transport	0.59	3
Transport services	0.35	4
Unprocessed food	0.44	3
Vegetables	0.36	3
Water supply	0.46	3
Water supply + miscellaneous services related to the dwelling	0.47	4

Table 9 continued

Wine	0.40	2
CORE ITEMS		
All items	0.60	4
CPI – fresh fruit-vegetables-fuels	0.59	3
CPI – fuels	0.63	2
CPI – education, health, social protection	0.52	2
CPI – housing, water, electricity, gas, other fuels	0.40	4
CPI – liquid fuels	0.77	4
CPI – energy	0.53	4
CPI – energy – seasonal food	0.44	3
CPI – energy – unprocessed food	0.63	3
CPI – energy – food – alcohol – tobacco	0.64	4
CPI – seasonal food	0.63	3
CPI – tobacco	0.33	3
CPI – fish – sea food	0.45	4
CPI – food	0.46	4
GDP DEFLATOR		
All items	0.37	3

The results in Table 9 suggest a moderate degree of inflation persistence in the majority of disaggregated indices. Durable goods tend to be relatively more persistence than other indices.

Moreover, our results do not conform the fact that aggregate inflation exhibits a higher degree of persistence than the disaggregated indices. The fact that price inflation is not necessarily more persistent at the aggregate level than at the disaggregated level is a feature that contrasts sharply with the conventional wisdom as well as with the evidence reported in Boivin et al. (2007) for the United States. Moreover, the alignment between aggregate and disaggregated persistence contrasts also with the view of Altissimo et al. (2007), who claim that persistence in aggregate inflation may reflect an aggregation bias due to the high degree of heterogeneity in the persistence of the disaggregated components of the price index.

Our results display that the support to the above fact is mixed, depending on the definition of the disaggregated index under investigation. With respect to the Core inflation items, 5 items out of 13 are falling within the range between 0.77 and 0.60, while the remaining 8 items are falling within the range between 0.59 and 0.30. With respect to the CPI index, 35 items out of 97 are falling within the range between 0.70 and 0.50, 35 items out of 97 are falling within the range between 0.49 and 0.40, while the remaining 27 items are falling within the range between 0.39 and 0.30. These empirical findings provide little evidence of a high degree of inflation persistence, but rather the majority of the disaggregated series are characterized by a low to moderate degree of persistence. Nevertheless, the estimated parameters vary substantially across indices as well as across disaggregated items. Moreover, the lowest persistence is shown in items related to food, vegetables, clothing and footwear since they are largely affected by either seasonality of harvesting or by the end of season sales. By contrast, items related to housing and equipments display a relatively high degree of persistence.

Table 10 reports break dates at the sectoral level. The results point out that those dates are very similar to those reached above at the aggregate level. More specifically, sectoral level break dates appear to be impressively concentrated around the same break date for the aggregate CPI and Core inflation indices.

Table 10. Estimates break dates: Sectoral level

Inflation Measure	Break date
CPI ITEMS	
Electricity	1993:2
Electricity + gas + other fuels	1993:2
Electricity + gas + solid fuels + heat energy	1993:2
Energy	1993:3
Energy + seasonal food	1993:2
Energy + unprocessed food	1993:2
Fresh food and vegetables	1993:1
Fuels	1993:3
Goods-food-non alcoholics	1993:3
Services	1993:2
Unprocessed food	1993:2
Unprocessed food & energy	1993:2
Accompany services	1993:3
Actual rentals for housing	1993:1
Alcoholic beverages	1993:3
Alcoholic beverages + tobacco	1993:3
Audio visual, photographic, info processing equipment	1993:2
Beer	1993:2
Books	1993:2
Bread and cereals	1993:3

Table 10 continued

Canteens	1993:3
Carpets + other floor coverings	1993:2
Catering services	1993:2
Cleaning repair + hire of clothing	1992:4
Clothing	1992:4
Clothing and footwear	1992:4
Clothing materials	1992:4
Coffee, tea, cocoa	1993:3
Combined passenger transport	1993:3
Communications	1993:2
Cultural services	1993:2
Domestic + household services	1993:2
Durables for recreation + musical instruments	1993:3
Education	1993:3
Education + health + social protection	1993:3
Electrical appliances + products for personal care	1993:2
Equipment for reception, recording of sound + pictures	1993:3
Equipment for sport, camping + open air recreation	1993:3
Food + non alcoholic beverages	1993:3
Food + alcohol + tobacco	1993:3
Footwear, including repair	1993:2

Table 10 continued

Fruits	1993:3
Fuel + lubricants for personal transportation equipment	1993:2
Furnishing + household equipment + routine house maintenance	1993:3
Furniture + furnishing + carpets + other floor coverings	1993:1
Furniture + furnishing	1993:1
Games, toys, hobbies	1992:3
Gardens, plants, flowers	1993:1
Garments	1993:1
Gas	1993:3
Glassware, tableware, household utensils	1993:2
Goods, services for routine household maintenance	1993:3
Goods – services	1993:3
Hairdressing salons + personal grooming establishments	1993:1
Health	1993:2
Household appliances	1993:3
Household appliances + electrical	1993:3
Household textiles	1993:3
Housing, water, electricity, gas, other fuels	1993:3
Industrial goods	1993:3

Table 10 continued

Information processing equipment	1993:3
Insurance	1993:2
Insurance connected with the dwelling	1993:2
Insurance connected with the transportation	1993:2
Jewelers, clocks, watches	1993:1
Liquid fuels	1993:3
Liquid fuels + lubricants for Personal transportation equipment	1993:3
Maintenance repair of personal + transportation equipment	1993:3
Maintenance + repair of the dwelling	1993:2
Materials for maintenance + repair of the dwelling	1993:3
Meat	1993:2
Medical products, appliances, equipment	1993:3
Milk, cheese, eggs	1993:2
Mineral water, soft drinks, fruits, vegetables juices	1993:2
Miscellaneous printed materials, stationery + drawing materials	1993:1
Miscellaneous goods and services	1993:3
Motor cars	1993:3
Motor cycles and bicycles	1993:3

Table 10 continued

Newspapers and periodicals	1993:1
Newspapers, books, stationery	1993:1
Non alcoholic beverages	1993:2
Non durable household goods	1993:1
Non energy industrial goods	1992:4
Non energy industrial goods (durables)	1993:1
Non energy industrial goods (non durables)	1993:1
Non energy industrial goods (semi durables)	1993:2
Oil and fats	1993:3
Operation of personal transport equipment	1993:3
Other medical products, therapeutic appliances and equipment	1993:3
Other articles of clothing and clothing accessories	1993:2
Transport	1993:3
Transport services	1993:3
Unprocessed food	1993:2
Vegetables	1993:3
Water supply	1993:3
Water supply + miscellaneous services related to the dwelling	1993:3
Wine	1993:2

Table 10 continued

CORE ITEMS

CPI – fresh fruit-vegetables-fuels	1992:4
CPI – fuels	1992:4
CPI – education, health, social protection	1993:1
CPI – housing, water, electricity, gas, other fuels	1992:4
CPI – liquid fuels	1992:4
CPI – energy	1992:4
CPI – energy – seasonal food	1992:4
CPI – energy – unprocessed food	1992:4
CPI – energy – food – alcohol – tobacco	1992:4
CPI – seasonal food	1992:4
CPI – tobacco	1993:1
CPI – fish – sea food	1992:4
CPI – food	1992:4

Next, under the presence of a break, persistence was estimated before and after the Maastricht event. Table 11 reports the prior and post Maastricht persistent measures for the aggregate inflation indices.

Table 11. Inflation persistence measures (with a break in the intercept)

GDP Deflator-Break Point, 1993:2	
Prior 1993:2	0.35
Post 1993:2	0.40
CPI-Break Point, 1993:2	
Prior 1993:2	0.51
Post 1993:2	0.57
Core-Break Point, 1992:4	
Prior 1992:4	0.55
Post 1992:4	0.62

The results in Table 11 denote that Greek inflation displays a small shift (upwards) in persistence prior and post the Maastricht Treaty event regarding all three alternative inflation definitions. Our results seem to be in line with those reached by Hondroyiannis and Lazaretou (2004) for the case of Greece as well as by Levin and Piger (2004) and Cogley and Sbordone (2008) for the case of a sample of industrialized economies. They are also in line with those reached by Benati (2008) regarding the fact that inflation persistence depends closely on the effectiveness of a nominal anchor for monetary policy. Although the implementation of the monetary policy by a central monetary authority (the ECB) was expected to have lowered not only the mean of inflation but also its persistence, the results in Table 11 support that some other factors, i.e. fiscal or demographic, could have contributed to such an upward movement in the Greek inflation persistence (Zaffaroni, 2004). They are, however, in contrast to those reached by Taylor (2000), Batini and Nelson (2001) and Sbordone (2002) for the cases of the U.S. and the U.K.

Next, this section investigates persistence estimates at sectoral level before and after the corresponding break dates identified in Table 10. In the sectoral persistence results prior- and post the break data, reported in Table 12, the sector aggregates can be split into main categories: services and industrial goods in the first, and food and energy prices in the second. Inflation persistence measures included in the first category display higher values over the post break date period, while those included in the second category exhibit lower values over the same period. According to Baudry *et al.* (2004), these findings imply that the categories of disaggregated indices that display higher inflation persistent values are those sectors with the largest component that looks backward.

Table 12. Estimates of inflation persistence (with a break in the intercept): Sectoral series

Inflation Measure	Persistence measure	Break date
<u>CPI ITEMS</u>		
Electricity	0.49-0.53	1993:2
Electricity + gas + other fuels	0.48-0.53	1993:2
Electricity + gas + solid fuels + heat energy	0.50-0.55	1993:2
Energy	0.49-0.55	1993:3
Energy + seasonal food	0.51-0.56	1993:2
Energy + unprocessed food	0.51-0.57	1993:2
Fresh food and vegetables	0.49-0.54	1993:1
Fuels	0.52-0.56	1993:3
Goods-food-non alcoholics	0.50-0.62	1993:3
Services	0.53-0.64	1993:2
Unprocessed food	0.51-0.56	1993:2
Unprocessed food & energy	0.49-0.55	1993:2
Accompany services	0.52-0.68	1993:3
Actual rentals for housing	0.52-0.61	1993:1
Alcoholic beverages	0.54-0.59	1993:3
Alcoholic beverages + tobacco	0.53-0.60	1993:3
Audio visual, photographic, info processing equipment	0.50-0.67	1993:2
Beer	0.51-0.56	1993:2
Books	0.48-0.65	1993:2
Bread and cereals	0.51-0.55	1993:3

Table 12 continued

Canteens	0.50-0.56	1993:3
Carpets + other floor coverings	0.53-0.61	1993:2
Catering services	0.50-0.65	1993:2
Cleaning repair + hire of clothing	0.52-0.61	1992:4
Clothing	0.50-0.62	1992:4
Clothing and footwear	0.52-0.63	1992:4
Clothing materials	0.48-0.62	1992:4
Coffee, tea, cocoa	0.51-0.56	1993:3
Combined passenger transport	0.53-0.63	1993:3
Communications	0.50-0.64	1993:2
Cultural services	0.53-0.66	1993:2
Domestic + household services	0.50-0.62	1993:2
Durables for recreation + musical instruments	0.53-0.62	1993:3
Education	0.52-0.65	1993:3
Education + health + social protection	0.53-0.64	1993:3
Electrical appliances + products for personal care	0.53-0.67	1993:2
Equipment for reception, recording of sound + pictures	0.52-0.65	1993:3
Equipment for sport, camping + open air recreation	0.50-0.64	1993:3
Food + non alcoholic beverages	0.52-0.55	1993:3
Food + alcohol + tobacco	0.54-0.56	1993:3
Footwear, including repair	0.52-0.58	1993:2

Table 12 continued

Fruits	0.52-0.57	1993:3
Fuel + lubricants for personal transportation equipment	0.54-0.58	1993:2
Furnishing + household equipment + routine house maintenance	0.52-0.61	1993:3
Furniture + furnishing + carpets + other floor coverings	0.50-0.62	1993:1
Furniture + furnishing	0.52-0.63	1993:1
Games, toys, hobbies	0.54-0.62	1992:3
Gardens, plants, flowers	0.54-0.65	1993:1
Garments	0.53-0.65	1993:1
Gas	0.52-0.58	1993:3
Glassware, tableware, household utensils	0.52-0.61	1993:2
Goods, services for routine household maintenance	0.52-0.62	1993:3
Goods – services	0.53-0.64	1993:3
Hairdressing salons + personal grooming establishments	0.55-0.64	1993:1
Health	0.49-0.67	1993:2
Household appliances	0.50-0.62	1993:3
Household appliances + electrical	0.51-0.61	1993:3
Household textiles	0.49-0.60	1993:3
Housing, water, electricity, gas, other fuels	0.50-0.64	1993:3
Industrial goods	0.54-0.66	1993:3

Table 12 continued

Information processing equipment	0.49-0.62	1993:3
Insurance	0.49-0.68	1993:2
Insurance connected with the dwelling	0.49-0.65	1993:2
Insurance connected with the transportation	0.50-0.66	1993:2
Jewelers, clocks, watches	0.55-0.62	1993:1
Liquid fuels	0.52-0.58	1993:3
Liquid fuels + lubricants for Personal transportation equipment	0.47-0.55	1993:3
Maintenance repair of personal + transportation equipment	0.53-0.64	1993:3
Maintenance + repair of the dwelling	0.49-0.62	1993:2
Materials for maintenance + repair of the dwelling	0.50-0.63	1993:3
Meat	0.50-0.56	1993:2
Medical products, appliances, equipment	0.49-0.61	1993:3
Milk, cheese, eggs	0.50-0.56	1993:2
Mineral water, soft drinks, fruits, vegetables juices	0.51-0.58	1993:2
Miscellaneous printed materials, stationery + drawing materials	0.50-0.60	1993:1
Miscellaneous goods and services	0.52-0.61	1993:3
Motor cars	0.55-0.68	1993:3
Motor cycles and bicycles	0.52-0.67	1993:3

Table 12 continued

Newspapers and periodicals	0.49-0.63	1993:1
Newspapers, books, stationery	0.50-0.58	1993:1
Non alcoholic beverages	0.53-0.57	1993:2
Non durable household goods	0.51-0.59	1993:1
Non energy industrial goods	0.55-0.66	1992:4
Non energy industrial goods (durables)	0.54-0.65	1993:1
Non energy industrial goods (non durables)	0.52-0.67	1993:1
Non energy industrial goods (semi durables)	0.53-0.67	1993:2
Oil and fats	0.48-0.69	1993:3
Operation of personal transport equipment	0.49-0.64	1993:3
Other medical products, therapeutic appliances and equipment	0.49-0.63	1993:3
Other articles of clothing and clothing accessories	0.51-0.60	1993:2
Transport	0.50-0.65	1993:3
Transport services	0.51-0.66	1993:3
Unprocessed food	0.48-0.59	1993:2
Vegetables	0.52-0.58	1993:3
Water supply	0.51-0.58	1993:3
Water supply + miscellaneous services related to the dwelling	0.50-0.57	1993:3
Wine	0.50-0.56	1993:2

Table 12 continued

CORE ITEMS

CPI – fresh fruit-vegetables-fuels	0.53-0.65	1992:4
CPI – fuels	0.53-0.63	1992:4
CPI – education, health, social protection	0.52-0.59	1993:1
CPI – housing, water, electricity, gas, other fuels	0.50-0.61	1992:4
CPI – liquid fuels	0.52-0.65	1992:4
CPI – energy	0.53-0.66	1992:4
CPI – energy – seasonal food	0.51-0.64	1992:4
CPI – energy – unprocessed food	0.53-0.62	1992:4
CPI – energy – food – alcohol – tobacco	0.54-0.63	1993:1
CPI – seasonal food	0.50-0.64	1992:4
CPI – tobacco	0.51-0.64	1993:1
CPI – fish – sea food	0.52-0.67	1992:4
CPI – food	0.54-0.68	1992:4

Notes: Figures before the – denote persistence measures prior to the break date, while those after the – denote persistence measures post the break date.

Conclusions

This part of the study analysed the degree of inflation persistence in Greece across three main price indices, the CPI, the Core index and the GDP deflator and using classical methods to estimate univariate AR models of inflation over the period 1981-2009 for the case of CPI and GDP deflator and over the period 1989-2009 for the case of Core inflation. Thanks to the use of highly disaggregated time series, the dynamics of Greek inflation could be clearly analyzed. In particular, the empirical findings of this chapter reveal substantial homogeneity across sectors as well as across price indices. These results also suggest a very moderate degree of inflation persistence for both aggregate and disaggregate price indices. For the majority of alternative price indices the inflation persistence measures were estimated to be within the range of 0.50-0.70. In addition, for the case of CPI we found support (at least for the majority of sectoral indices) for an aggregation effect in the sense of aggregate inflation exhibiting a greater degree of inflation persistence than the disaggregated series. However, this aggregation effect is minimized when using Core inflation items. In addition, our results pointed to the need to account for the presence of a structural break in all of the inflation series under investigation. The break was typically related to the 'Maastricht effect; and entailed a structural increase in the persistence measure, though the average level of inflation declined. The timing of this regime shift is highly suggestive of a link between monetary policy regimes and the persistence of inflation. Moreover, this could be a piece of evidence that although the monetary component of inflation in Greece was neutralized due to the implementation of the monetary policy by a central monetary authority (this new monetary regime could imply a relatively stable level of inflation in the long-run), other idiosyncratic characteristics of the Greek inflation, such as non-competitive forces in many sectors in the economy as well as public deficits, could have contributed to this persistent structure of the inflation series. Nevertheless, the omission of such a break could affect substantially the results, leading to invalid measurements of inflation persistence.

Finally, with regard to individual indices, the empirical results displayed that services and industrial goods were characterized by higher persistence measures than food and energy prices. These findings could insinuate that the categories of disaggregated indices that display higher inflation persistent values are those sectors with the largest component that looks backward.

A number of extensions could be envisaged. First, extending the framework of the empirical analysis to a multivariate analysis, which could enhance the robustness of our empirical findings, could control for a number of events. This will also enable us to analyze the extent to which shifts in monetary policy regimes could influence the dynamic behaviour of inflation. Finally, we could also apply these techniques to structural models of wage and price settings, thereby, enabling us to disentangle the extent to which estimates of inflation persistence can be confounded by occasional shifts in the monetary policy regime.

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Chapter 2. Mean Spillover Effects among CPI Components.

Introduction

The reaction of consumer prices and inflation to fuel price movements has been investigated by many authors, such as Hooker (2002), Barsky and Kilian (2004) and LeBlanc and Chinn (2004). While Barsky and Kilian (2004) argue that fuel prices increases generate strong inflationary shocks, LeBlanc and Chinn (2004) argue that fuel prices have only a moderate effect on inflation. Moreover, Ferderer (1996) argues that inflation has a negative impact on investment, through a rise in firms' costs and higher uncertainty, leading to postponement of investment decisions and, thus, to lower production and, through conditions of excess demand, to further higher prices.

The use of highly aggregated data for causal inference is quite common in the applied econometric literature. On one side there are researchers who use Granger causality tests with mostly quarterly or annual data (Jung and Marshall, 1985; Rao 1989; Demitriades and Hussein 1996). On the other side are those who use cross-country regressions with data averaged over many years. Causality in these studies is pre-imposed and testing is done on the contemporaneous correlations (Grier and Tullock, 1989; Barro, 1991; Levine and Renelt, 1992; King and Levine, 1993; Levine and Zervos, 1993; Frankel and Roamer, 1999). A number of the above studies have focused on aggregation and the dynamic relationships between variables and shown that aggregation weakens the distributed lag relationships. In addition, they find that aggregation turns one-way causality into a feedback system, while it produces inconsistent estimates and induces endogeneity into previously exogenous variables. Although these studies have already pointed out some potential problems associated with aggregated data, a comprehensive study that focuses on Granger causality with disaggregated data would be of immense value because of the practical significance of causality testing based on aggregated data. Finally, Gulasekaran and Abeysinghe (2002) and Gulasekaran (2004) have derived quantitative results using an analytical framework to assess the nature of the problems created. Overall, the following conclusions emerge. Within a stationary framework, aggregation may (i) create a spurious feedback loop from a unidirectional relation, (ii) erase a feedback loop and create a unidirectional relation and (iii) erase the Granger-causal link altogether. The distortions magnify when differencing is used after aggregation to induce stationarity.

In Greece, some components of the price index exhibit a differentiated behaviour and the relationship with disaggregated price indices may differ among them. It is also clear that it is hard to predict the part of inflation that is not related to domestic economic variables. For instance, fuel prices, which are an important cause of inflation, cannot be predicted with an acceptable degree of accuracy. Because of these reasons we also look at this problem on a disaggregated basis. Hence, our main research question is: ‘What is the nature of the causality between price inflation indices?’ Our secondary research question is: ‘Are disaggregated data more informative about inflationary developments than the main macroeconomic variables?’.

In this part of the study we thus aim to estimate the nature of the links between the abovementioned variables. As a result, since inflation is a painful problem, we would like to give our contribution to investigating and forming the economic rationale behind the policy decisions affecting prices in the Greek economy. Therefore, the objective as well as the novelty of this chapter is to investigate the behaviour of various CPI components in terms of their spillover behaviour. It is expected that certain CPI components would have not been so responsive to changes in other CPI components.

This is believed to be the first study analyzing the causal relationship between CPI components in Greece. Our analysis thus encloses the information from all available sectors of the price index. The research on commodities prices spillover effects has focused exclusively on the international transmission of such indexes movements. This paper, in contrast, tests whether movements in CPI components initially affect one another.

Among the time series approaches univariate measures (as those employed in Chapter 1 of this study) are distinguished from multivariate methods. The univariate measures differ with respect to the smoothing techniques that are applied. Simple methods like taking moving averages. The multivariate methods basically comprise the vector autoregression (VAR) approach suggested to the measurement of any type of inflation by Quah and Vahey (1995).

Empirical Analysis

For the empirical purposes of this chapter, the data set used in Chapter 1 is used again. Thus, the short-run dynamic interactions among the variables are characterized by feedbacks going from one variable to the other or in both directions, depending on the causal relationship. This provides justification for examining the direction of the causal links among the variables under consideration through Granger causality tests.

Several time-series methods have been developed to study interrelationships among various variables, including commodities price indices. Vector Autoregression (VAR) models have extensively been used to study the contemporaneous correlations among various indices and to examine the dynamic response of certain markets to artificial shocks. We use a VAR model to study the interrelationships between the various components of the CPI index in Greece. The VAR model allows us to capture both the contemporaneous and lagged influence of the endogenous variables on each other. It is also well suited to study dynamic responses of the variables to shocks by way of the variance decomposition (VDCs) analysis. Another important property of VAR models is that it is not restrictive if error terms are serially correlated, because any serial correlation can be removed by adding more lags to the dependent variables.

To serve better our research goal and to overcome certain statistical deficiencies due to the lack of adequate observations, we aggregate (as a weighted average) certain CPI components. In particular, the following categories of CPI will be used in the analysis: Electricity (EL), Energy (EN), Fuels and gas (FG), Food and vegetables (FV), Services (SER), Beverages (BEV), Durables (DUR), Education (ED), Health (H) and Semi-durables (including clothing, footwear and furniture) (SDUR). Throughout the empirical analysis, lower case letters indicate variables in logarithms.

Unit Roots Tests

The results related to unit root tests are reported in Table 1. The ADF test is based on the following regression model, assuming a drift and linear time trend:

$$\Delta y_t = a_0 + \sum_{i=1}^{p} \Delta y_{t-1} + \beta\, t + \gamma\, y_{t-1} + \varepsilon_t$$

where *t* = time trend and ε_t = random error. The null hypothesis in the ADF test is that there is a unit root where $\gamma = 0$. For all the variables to be stationary, we must reject the null hypothesis in favour of the alternative hypothesis.

As suggested by Enders (1995), we carried out unit root tests on the endogenous variables. Based on augmented Dickey-Fuller [1981] tests, the hypothesis that the variables el, en, fg, fv, ser, bev, dur, ed, h and sdur contain a unit root cannot be rejected at the 5 percent significant level. When first differences are used, unit root nonstationarity is rejected at the 5 percent significant level, suggesting that all the variables under study are I(1) variables.

Table 1. Augmented Dickey-Fuller unit-root tests

	Without Trend		With Trend	
Variables	Levels	First Differences	Levels	First Differences
el	-0.88(4)	-4.11(3)*	-0.99(3)	-4.36(2)*
en	-0.71(5)	-5.63(3)*	-1.74(3)	-7.14(2)*
fg	-0.34(4)	-4.71(3)*	-1.77(4)	-6.08(3)*
fv	-1.05(3)	-4.48(2)*	-1.93(4)	-5.11(2)*
ser	-1.54(3)	-4.56(2)*	-1.37(4)	-6.03(2)*
bev	-2.53(4)	-4.47(3)*	-2.84(4)	-4.93(2)*
dur	-1.78(4)	-4.84(3)*	-1.94(3)	-5.12(2)*
ed	-1.63(4)	-4.56(2)*	-1.85(4)	-4.88(2)*
h	-1.77(4)	-4.38(3)*	-2.10(4)	-4.69(3)*
sdur	-1.68(3)	-4.71(2)*	-1.90(4)	-4.93(3)*

Note: Figures in brackets denote the number of lags in the augmented term that ensures white-noise residuals. *denotes significance at the 5 percent level.

Granger-Causality Tests and Price Transmissions

To investigate the short-run interactions among the three prices under study, a VAR model is defined as:

$$\Delta P_t = C + \sum_{i=1}^{k} b_i \Delta P_{t-i} + \upsilon_t$$

where Δ is the difference operator; P_t is a vector of order 10 with elements el, en, fg, fv, ser, bev, dur, ed, h and sdur; B_i is a 10×10 coefficient matrix; υ_t is an error-terms vector; and C is a 10×1 constant vector. In this part of the study, we develop our ten-variable standard form Vector Autoregression (VAR) system, which includes the CPI price components series. Each variable is treated as endogenous and is regressed on lagged values of itself and the other variables. The intercept parameters are the only exogenous variables in the model. A VAR model is very appropriate because of its ability to characterize the dynamic structure of the model as well as its ability to avoid imposing excessive identifying restrictions associated with different economic theories. That is to say that such a model does not require any explicit economic theory to estimate various models. Moreover, its important feature is the employment of the estimated residuals, called VAR innovations, in dynamic analysis. These VAR innovations are treated as an intrinsic part of the system.

The estimation of the VAR model requires that we determine the appropriate lag length of the variables in the model where the maximum lag length n is chosen such that the residuals υ_t are white noise. We use the likelihood ratio test, as outlined in Hamilton (1994). Table 2 presents the results of the likelihood ratio tests for lag determination. The null hypothesis that a set of variables is generated from a VAR system with n lags is tested against the alternative specification of n_1 lags where $n < n_1$. Based on the Chi-square significance level, there is a clear support for the null hypothesis of four lags. We do not allow for different lag length since it is common to use the same lag lengths for all equations in order to preserve the symmetry of the system (Bayoumi and Eichengreen, 1992; Blanchard and Quah, 1989). Finally, all ten equations include a dummy variable that considers the 1992 EMU event. This variable takes values of one for the last quarter in 1992 and zero otherwise.

Table 2. Test results for the determination of the lag length in the VAR model

Null Hypothesis	Alternative Hypothesis	Acceptance Probability
4 lags	8 lags	0.999
4 lags	6 lags	0.658
2 lags	4 lags	0.003
3 lags	4 lags	0.007

Notes: Acceptance probability is based on the Chi-square distribution for the likelihood ratio test. Following the suggestions of Sims (1980), we take into account small sample bias by correcting the likelihood ratio statistic by the number of parameters estimated per equation. Thus, the likelihood ratio test = $T - C\{log[\Sigma_0] - log[\Sigma_1]\}$, where Σ_0 and Σ_1 are the variance covariance matrices of the residuals estimated from a VAR model with a constant and the number of lags under the null and alternative hypotheses, respectively. T is the number of used observations and C is the number of variables in the unrestricted equations. The degrees of freedom for the Chi-square test equal the number of restrictions implied by variation in the lag length.

Granger Causality Tests

Granger-causality is examined through Wald tests for block exogeneity, which allows us to examine whether the lag structure of an excluded variable adds to the explanatory power of the estimated equation. In other words, a test of causality is whether the lags of one variable enter the equation for another variable. Table 3 presents the most important Granger-causality test results. All equations support certain econometric diagnostics, such as absence of serial correlation (LM), absence of misspecification (RESET) and presence of homoskedasticity (HE).

In particular, electricity prices (el), energy prices (en) and fuel and gas prices (fg) Granger-cause all the remaining seven CPI components. Next, services prices (ser), education prices (ed) and health prices (h) Granger cause durables prices (dur) and semi-durables prices (sdur). Finally, Food and vegetables prices (fv) Granger cause education prices (ed) and health prices (h).

Table 3. Granger causality tests

Equation	Null Hypothesis	Wald-Statistic	p-value
Δfv	Electricity prices do not cause food and vegetables prices	22.35	0.00
LM = 6.54[0.52] RESET = 1.63[0.27] HE = 1.83[0.37]			
Δser	Electricity prices do not cause services prices	29.06	0.00
LM = 10.72[0.41] RESET = 1.42[0.34] HE = 0.81[0.49]			
Δbev	Electricity prices do not cause beverages and beer prices	21.36	0.00
LM = 16.33[0.27] RESET = 1.46[0.32] HE = 0.70[0.53]			
Δdur	Electricity prices do not cause durables prices	19.55	0.00
LM = 14.35[0.32] RESET = 1.49[0.31] HE = 0.93[0.47]			
Δed	Electricity prices do not cause education prices	35.82	0.00
LM = 13.27[0.37] RESET = 1.11[0.39] HE = 0.71[0.54]			
Δh	Electricity prices do not cause health prices	31.06	0.00
LM = 10.09[0.46] RESET = 1.16[0.44] HE = 0.49[0.69]			
$\Delta sdur$	Electricity prices do not cause semi-durables prices	21.28	0.00
LM = 5.43[0.67] RESET = 1.28[0.42] HE = 0.52[0.64]			
Δfv	Energy prices do not cause food and vegetables prices	24.71	0.00
LM = 15.49[0.37] RESET = 2.44[0.22] HE = 0.81[0.42]			
Δser	Energy prices do not cause services prices	17.11	0.00
LM = 13.29[0.43] RESET = 2.36[0.20] HE = 0.39[0.71]			
Δbev	Energy prices do not cause beverages and beer prices	25.46	0.00
LM = 17.40[0.27] RESET = 2.08[0.25] HE = 1.12[0.31]			
Δdur	Energy prices do not cause durables prices	18.89	0.00
LM = 16.44[0.30] RESET = 1.96[0.23] HE = 0.73[0.38]			
Δed	Energy prices do not cause education prices	39.76	0.00
LM = 3.58[0.81] RESET = 1.09[0.56] HE = 0.62[0.41]			
Δh	Energy prices do not cause health prices	28.93	0.00
LM = 14.42[0.26] RESET = 2.11[0.28] HE = 0.67[0.38]			
$\Delta sdur$	Energy prices do not cause semi-durables prices	23.28	0.00
LM = 11.07[0.33] RESET = 2.48[0.16] HE = 0.56[0.43]			

Table 3 continued

Δfv	Fuel prices do not cause food and vegetables prices	27.15	0.00
LM = 10.51[0.57] RESET = 1.36[0.24] HE = 0.72[0.39]			
Δser	Fuel prices do not cause services prices	18.88	0.00
LM = 9.37[0.68] RESET = 1.18[0.29] HE = 1.88[0.16]			
Δbev	Fuel prices do not cause beverages and beer prices	18.35	0.00
LM = 11.62[0.51] RESET = 1.72[0.21] HE = 0.52[0.42]			
Δdur	Fuel prices do not cause durables prices	17.24	0.00
LM = 12.35[0.48] RESET = 1.67[0.23] HE = 0.66[0.35]			
Δed	Fuel prices do not cause education prices	26.72	0.00
LM = 8.54[0.72] RESET = 1.19[0.18] HE = 0.62[0.45]			
Δh	Fuel prices do not cause health prices	26.33	0.00
LM = 9.11[0.53] RESET = 1.64[0.20] HE = 0.83[0.34]			
Δsdur	Fuel prices do not cause semi-durables prices	29.09	0.00
LM = 14.83[0.38] RESET = 2.06[0.13] HE = 0.62[0.44]			
Δdur	Services prices do not cause durables prices	37.19	0.00
LM = 13.72[0.50] RESET = 1.44[0.21] HE = 0.82[0.34]			
Δsdur	Services prices do not cause semi-durables prices	28.84	0.00
LM = 14.52[0.46] RESET = 1.72[0.19] HE = 0.75[0.35]			
Δdur	Education prices do not cause durables prices	34.48	0.00
LM = 7.38[0.68] RESET = 2.10[0.17] HE = 1.05[0.30]			
Δsdur	Education prices do not cause semi-durables prices	37.49	0.00
LM = 9.84[0.58] RESET = 1.81[0.20] HE = 0.82[0.34]			
Δdur	Health prices do not cause durables prices	36.82	0.00
LM = 17.48[0.28] RESET = 2.13[0.18] HE = 0.55[0.51]			
Δsdur	Health prices do not cause semi-durables prices	24.49	0.00
LM = 13.34[0.33] RESET = 1.66[0.24] HE = 0.84[0.40]			
Δed	Food and vegetables prices do not cause durables prices	41.01	0.00
LM = 11.92[0.46] RESET = 2.16[0.16] HE = 0.52[0.50]			
Δh	Food and vegetables prices do not cause semi-durables prices	34.58	0.00
LM = 11.32[0.47] RESET = 1.18[0.42] HE = 0.67[0.45]			

The results do not support the presence of significant feedbacks between aggregate CPI components.

Variance Decompositions

To ascertain the importance of the dynamic relationship among the variables under study, we obtained forecast error variance decompositions. Variance decompositions tell us the percentage of the variance in a variable that is due to its own "shock" and the "shocks" of the other variables in the VAR system. If a shock explains none of the forecast error variance of a particular variable at all forecast periods, it means that this particular variable evolves independently of the series. In other words, this variable sequence is exogenous. On the other extreme, the variable would be endogenous if all of its error variance is explained by the shock. This analysis allows us to examine the relative importance of each random innovation to the variables in the VAR system. In standard VAR methodology the contemporaneous correlation among the variables involved in the system is purged by the Cholesky orthogonalization procedure.

Tables 4 through 10 capture the variance decompositions and the results indicate that each series explains a substantial proportion of its own past values. It is also interesting to note that as the time horizon expands, a particular variable accounts for smaller proportions of its forecast error variance. The followed results correspond to the following ordering of equations: fv, el, en, fg, ser, bev, dur, ed, h, sdur. Generally speaking, this ordering reflects the fact that fuel prices have an influence on all the remaining variables in their model, but their own behaviour is least determined by other variables included in the model. This is quite a plausible assumption, because fuel prices are largely determined by world market conditions, rather than conditions within the Greek economy (although, tax policy may put extra burden to those who make use of fuel prices as well as to the rest of the economy, through the indirect channel of the cost of production).

Table 4 indicates that the variance in the food and vegetables index could be explained mainly by itself and developments in the electricity, energy and fuels and gas indices. Over a 20 quarter time period, between 35% and 40% of the forecast error variance in this index could be traced to the shocks in the three indices mentioned above. In the first quarter following the shock, the food and vegetables index explains about 41% of its own variance, while 16%, 10% and 9% is explained by the electricity, energy and fuels and gas indices, respectively. Only after the fourth quarter do we observe a significant portion of the food and vegetables index variance that is explained more heavily by the remaining price indices.

Table 4. Variance decompositions of food and vegetables price index (fv-%)

Period	fv	el	en	fg	ser	bev	dur	ed	h	sdur
1	41.1	16.2	10.3	9.0.	5.2	3.2	4.4	1.4	5.2	4.0
4	35.6	20.4	19.3	10.6	6.9	2.9	2.6	2.3	4.7	1.0
8	30.3	22.8	20.5	12.1	6.9	4.7	5.1	3.7	6.1	2.0
12	24.9	25.3	26.2	18.7	7.1	5.7	5.6	4.9	9.4	1.0

Notes: Numbers represent the percentage of the variance of the nth-period ahead forecast error for prices that are explained by the variables in the VAR model.

Table 5 shows the variance decompositions of the services price index. It indicates that in the very short-run the services index is mainly explained by the electricity price index (16%), the energy price index (10%), the semi-durable price index (11%) and the fuel and gas price index (8%). All these four price indices explain a relatively significant proportion of the services price index forecast error variance. Their portion remains at high levels even after 20 quarters. The results suggest that there is a significant spillover effect between services prices and energy prices. This seems to support our premise that the services sector movements are significantly affected by the developments and the cost structure in the energy sector even in the long-run.

Table 5. Variance decompositions of services price index (ser-%)

Period	fv	el	en	fg	ser	bev	dur	ed	h	sdur
1	4.5	15.7	10.0	8.0.	35.3	2.5	6.4	4.4	2.2	11.0
4	4.7	19.4	12.9	9.2	29.5	2.5	5.8	4.5	2.5	9.0
8	5.6	21.4	15.3	10.2	22.5	3.9	6.2	4.8	4.1	6.0
12	6.2	24.2	18.0	13.3	17.4	4.1	6.1	4.8	4.9	4.0

Note: Similar to Table 4.

Table 6 summarizes the forecast error decomposition of the beverages and beer price index. It seems that this index's movements are explained by a sizeable proportion of the three price indices related to the energy sector error variance both in the short- and in the long-run. This is an interesting finding as we expected that one more industrial sector's cost movements in Greece would be affected by energy sector's developments.

Table 6. Variance decompositions of beverages and beer price index (bev-%)

Period	fv	el	en	fg	ser	bev	dur	ed	h	sdur
1	5.0	17.3	11.1	10.0.	4.1	32.0	3.4	3.2	7.2	6.7
4	5.2	19.0	12.5	11.4	4.5	23.6	3.9	3.8	7.6	8.5
8	5.0	22.5	14.2	13.6	5.2	19.3	4.3	4.2	7.7	4.0
12	4.8	24.1	16.7	14.7	5.9	12.5	5.0	4.6	8.3	3.4

Note: Similar to Table 4.

Table 7 shows the variance decompositions of the durables price index. It indicates that in the very short-run the index is mainly explained by the electricity price index (15.3%), the energy price index (10.5%), the fuel and gas price index (12.4%) and the services price index (18.1%).

All these four price indices explain a relatively significant proportion of the durables price index forecast error variance. Their portion remains at high levels even after 20 quarters, i.e. about 70%. The results suggest that there is a significant spillover effect between durables prices and energy and services prices. This seems to support our premise that durables industrial sector movements are significantly affected by the developments and the cost structure in the energy sector as well as by developments in the services sector even in the long run.

Table 7. Variance decompositions of durables price index (dur-%)

Period	fv	el	en	fg	ser	bev	dur	ed	h	sdur
1	5.1	15.3	10.5	12.4.	18.1	2.3	25.3	4.3	7.7	1.0
4	5.2	17.1	11.0	13.8	18.2	2.6	20.2	4.5	7.4	0.0
8	5.4	19.5	12.4	15.2	18.2	2.3	14.7	4.1	7.1	1.2
12	5.6	20.1	13.4	17.1	18.9	2.5	10.5	4.0	7.2	0.7

Note: Similar to Table 4.

Tables 8 and 9 summarize the forecast error decomposition of the education and the health price index, respectively. It seems that these indices' movements are explained by a sizeable proportion of the three price indices related to the energy sector error variance along with that from the food and vegetables sector both in the short- and in the long-run, 54% and 65%, respectively for the education sector and 46% and 64%, respectively for the health sector. This is an interesting finding as we expected that non-industrial sectors' cost movements would be mainly affected by energy sector's developments.

Table 8. Variance decompositions of education price index (ed-%)

Period	fv	el	en	fg	ser	bev	dur	ed	h	sdur
1	15.1	16.6	10.1	14.5.	4.1	2.0	5.6	24.1	7.3	0.6
4	16.2	17.6	11.5	15.4	4.2	2.3	5.7	19.2	6.4	0.5
8	16.6	20.3	12.7	17.5	4.2	2.0	5.9	13.7	6.2	0.9
12	17.1	21.5	13.4	18.3	3.2	2.4	6.3	12.4	6.0	0.4

Note: Similar to Table 4.

Table 9. Variance decompositions of health price index (h-%)

Period	fv	el	en	fg	ser	bev	dur	ed	h	sdur
1	14.2	17.5	10.5	15.8.	3.2	1.1	5.9	2.0	27.3	2.5
4	15.2	19.4	11.9	17.0	3.7	1.3	4.9	1.3	24.7	0.6
8	15.3	21.1	12.3	17.7	3.9	2.1	5.3	1.6	20.4	0.3
12	16.1	21.8	13.5	18.6	3.1	2.2	5.6	1.3	15.7	2.1

Note: Similar to Table 4.

Finally, Table 10 shows the variance decompositions of the semi-durables price index. It indicates that in the very short-run the index is mainly explained by the electricity price index (24.1%), the energy price index (15.6%) and the fuel and gas price index (20.1%). All these three price indices explain a relatively significant proportion of the durables price index forecast error variance. Their portion remains at high levels even after 20 quarters. The results suggest that there is a significant spillover effect between semi-durables prices and energy prices. This seems to support our premise that semi-durables industrial sector movements are significantly affected by the developments and the cost structure in the energy sector both in the short and in the long run.

Table 10. Variance decompositions of semi-durables price index (sdur-%)

Period	fv	el	en	fg	ser	bev	dur	ed	h	sdur
1	2.1	24.1	15.6	20.1.	2.2	1.4	4.3	1.7	6.2	22.3
4	2.4	26.7	17.5	22.3	2.5	1.6	3.5	1.8	4.8	18.9
8	2.3	27.4	18.3	24.1	2.7	2.0	3.6	1.8	3.2	14.6
12	2.2	28.8	19.5	24.5	2.9	2.0	3.6	1.9	3.1	11.5

Note: Similar to Table 4.

Discussion

Our empirical analysis shows that the empirical findings have highlighted the causality running from fuel prices towards the other CPI components. In other words, any rises in fuel prices pass on to the remaining parts of the economy and from the consumer standpoint (households and industry) the energy bill grows, whereas from the production standpoint, firms have to content with a rise in unit costs, and, therefore, in their charging prices. Thus, such rises in fuel prices represent an inflationary shock that is accompanied by second-round effects. More particularly, our results show that in Greece any oil price increases affect mainly the conditions of the supply side in the economy since energy is the primary input of the production process (Greece is heavily dependent on oil imports to satisfy their domestic needs for production and consumption). As a result, the cost of production increases. Thus, our empirical findings allow energy prices to affect the Phillips curve, which maps deviations of actual inflation from targeted inflation (set by the European Central Bank) to the current level of output gap, to capture inflationary effects in all sectors of the economy, and, in turn, to change the trade-off between inflation and unemployment in the Greek economy.

These empirical findings are also supported by the Real Business Cycle (RBC) theory whereby energy price shocks are considered as supply or technological regress. Moreover, following energy price rises, households may ask for increasing wages to restore their purchasing power, leading to price-wage loops. Next, turning to the firms, they can pass on such energy and wage rises to selling prices, which generate upward revisions of higher price expectations, which are diffused in all components of economic activity, especially in all manufacturing and service sectors.

The above findings imply that Greek economic authorities could not afford worrying only about growth and unemployment, but also about inflation, though the participation in the Euroland was supposed to alleviate the most part of this inflation burden. In other words, the Greek inflation problem can been handled either through the channel of tax policy or, primarily, through the deregulation and the opening of certain sectors in the economy characterized by monopolistic or oligopolistic conditions as well as through a stronger labour market flexibility (the so called structural economic changes). In particular, the lack of open markets impedes competition from driving down prices. According to NCCD (2006), Greece is considered to be the least 'trade open' economy among the remaining European Union members, with trade covering only 15% of GDP. This feature of the economy makes the life of domestic monopolistic markets easier, as competition from abroad is restricted, leading to prices acceleration.

Conclusions and Policy Implications

This chapter of the study examined the relationship among various CPI components for the case of the Greek economy. The analysis covered the period 1989 to 2006 (on a quarterly basis) and considered the CPI components price indices. Our results indicated the primary price movements are transmitted from the energy price indices, i.e. the electricity price index, the energy price index and the fuels and gas price index, while a secondary role also comes from the food and vegetables price index along with the services price index.

In addition and in terms of causality, the evidence indicates that there is a unidirectional transmission of energy prices disturbance to the remaining CPI components, while innovations (shocks) to the remaining CPI components did not have any significant effect on all indices. The implication is that certain sectors are shielded from disturbances originating sectors excluding those related to energy prices.

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Chapter 3. The Domestic Balassa-Samuelson Effect of Inflation

Introduction

Retrospection of the empirical literature pinpoints a large interest for the presence of significant inflation differentials in the euro area and the entailing effect on the competitiveness of those countries with higher inflation. To the extent that the inflation differential between a country and its salient trading partners is due to higher prices in the non-tradable sector, the competitiveness of the particular country will be unaffected. Therefore, countries which exhibit high inflation rates should not be fretted over the prospect of dwindling competitiveness as far as these rates are explained by the Balassa-Samuelson (BS) effect.

This chapter of the study aims at investigating whether and to what extent inflation differentials between the tradable and non-tradable sectors in the Greek economy are due to the BS effect. The empirical analysis will determine the size of the BS effect as well as the proportion of inflation attributable to it. Emphasis is given exclusively on the domestic version of it. In other words, we will not take into consideration the fact that Greece is trading with other countries that also experience the BS effect.

The BS effect[1] (Balassa 1964; Samuelson 1964) attempts to explain why in some cases purchasing-power parities calculated as a ratio of consumer goods prices for any pair of countries do not tend to approximate the equilibrium rates of exchange as PPP would predict. It surmises that emerging economies that are usually trying to catch up the developed economies, give more emphasis on the tradable sector; therefore, productivity in the tradable sector usually rises faster than in the non-tradable sector in these countries. More specifically, a rise in the productivity of the tradable sector leads to higher wages in both sectors so that producers in the non-tradable sector can meet higher wages if there is a simultaneous rise in the relative price of goods produced in the non-tradable sector. Nevertheless, the BS effect approach has received some

[1] Balassa and Samuelson regard productivity growth differentials between the tradable and non-tradable as a factor introducing systematic biases into the relationship between relative prices and real exchange rates.

criticism on the grounds that the approach holds under the assumption of perfect labour mobility between the two sectors under investigation. However, differential productivity rates between these two sectors along with the hypothesis of perfect labour mobility is very likely to lead to inflation rates in the tradable sector that are systematically different from those held in the non-tradable sector.

Certain studies have tested the importance of the BS effect in explaining inflation differential, mainly for the European area economies (De Grauwe and Skudelny (2000) and Canzoneri *et al.* (2002). These studies report evidence in favour of the BS effect. For Greece, Swagel (1999) estimates the BS effect by using the cointegration approach between relative prices and relative productivities. His results provide evidence in favour of a strong BS effect (1.7 percentage points).

A corporation that exists in a competitive environment seeks to maximize its profits and decides to lease a marginal labour unit only if the marginal revenue (P* MP_L) exceeds the marginal cost (W). Thus, the corporation demand for labour is defined by the following equation: P* $MP_L = W$. Any increase in tradable productivity raises nominal wages, with the tradable's prices remaining unchanged due to international competition. Conjecturing perfect labour mobility (i.e., labour is free to migrate between sectors of an economy) between tradable and non-tradable in conjunction with equalized nominal wages in both sectors brings about the coercion of non-tradable producers to raise the prices of their products to offset the augmented costs. However, the higher implied aggregate price level does not insinuate a loss of competitiveness. To establish this phenomenon formally, consider the following Cobb-Douglas production functions for the traded and non-traded sectors:

$$Y_t = A_t L_t^{a_t} K_t^{1-a_t} \quad \text{and} \quad Y_n = A_n L_n^{a_n} K_n^{1-a_n}$$

where t and n refer to the traded and non-traded sectors respectively, Y is output, A's are productivity shifters, L is labour and K is capital, while the parameters a and 1-a pertain to labour's and capital's shares, respectively. Assuming that corporations are subject to perfect competition and profit maximization, the level of wages W for both sectors is equal to the marginal revenue product of labour. Hence, W expressed in terms of tradable is given by :

$$W = a_t A_t \left(\frac{K_t}{L_t} \right)^{1-a_t} \quad \text{and} \quad W = \frac{P_n}{P_t} a_n A_n \left(\frac{K_n}{L_n} \right)^{1-a_n}$$

Note that the equality of W across sections is due to the assumption that labour is perfectly mobile. By re-expressing the production functions as capital to labour ratios, we obtain:

$$\frac{K_t}{L_t} = \left(\frac{Y_t}{A_t L_t} \right)^{\frac{1}{1-a_t}} \quad \text{and} \quad \frac{K_n}{L_n} = \left(\frac{Y_n}{A_n L_n} \right)^{\frac{1}{1-a_n}}$$

Substituting these ratios into above yields:

$$a_t \left(\frac{Y_t}{L_t} \right) = \frac{P_n}{P_t} a_n \left(\frac{Y_n}{L_n} \right)$$

Log-linearising the above equation and solving for sectoral inflation differentials yields:

$\log P_n - \log P_t = \log Y_t - \log L_t - \log Y_n + \log L_n$

Next, we log-linearise the production function from the first equation we obtain:

$\log Y_t = \log A_t + a_t \log L_t + (1-a_t)\log K_t$

$\log Y_n = \log A_n + a_n \log L_n + (1-a_n)\log K_n$

Substituting the above two equations we get:

$\log P_n - \log P_t = \log A_t + a_t \log L_t + (1-a_t)\log K_t - \log L_t - \log A_n - a_n \log L_n - (1-a_n)\log K_n + \log L_n$

which entails:

$\log P_n - \log P_t = \log A_t - \log A_n - a_t(\log K_t - \log L_t) + (\log K_t - \log L_t) +$

$+ a_n(\log K_n - \log L_n) - (\log K_n - \log L_n)$

where, the Solow residual for the tradeables and the non-tradeables is given by:

$\log A_t = \log Y_t - a_t \log L_t - (1-a_t)\log K_t$ and

$\log A_n = \log Y_n - a_n \log L_n - (1-a_n)\log K_n$

The interest rate R for both sectors is equal to the marginal revenue product of capital.

$$R = (1 - a_t) A_t \left(\frac{K_t}{L_t} \right)^{-a_t} \text{ and } R = \frac{P_n}{P_t} (1 - a_n) A_n \left(\frac{K_n}{L_n} \right)^{-a_n}$$

Note that the equality of R across sectors is based on the assumption that capital is perfectly mobile and since the standard small open economy assumption is also employed, R is fixed and equal to the world interest rate. Therefore, the first-order conditions imply that:

$(\log K_t - \log L_t) = \log A_t / a_t$ and $(\log K_n - \log L_n) = (\log P_n - \log P_t + \log A_n) / a_n$.

Substituting this equation into above yields the equivalent result of the non-traded and traded inflation differential:

$$\log P_n - \log P_t = \frac{a_n}{a_t} \log A_t - \log A_n$$ [2]

One can see that the inflation differentials between the two sectors are contingent on the Total Factor Productivity (TFP) growth differentials between them plus the ratio of non-tradables' labour share to tradables' labour share. Provided that the inequality $a_n \geq a_t$ holds, faster productivity growth in tradable than in non-tradable will push the price of non-tradable upward over time. The effect is greater the more labour-intensive are non-tradable relative to tradable. Assuming that the price level is a geometric average, with weights γ and $1-\gamma$, of the prices of tradable and non-tradable:

$\frac{P}{P_t} = \left(\frac{P_t}{P_t} \right)^{\gamma} \left(\frac{P_n}{P_t} \right)^{1-\gamma}$ and log-linearising we obtain that $\log P = \gamma \log P_t + (1-\gamma) \log P_n$. This final equation states that aggregate inflation can be expressed as a weighted average of traded and non-traded inflation. Combining the above equations yields:

$\log P = \log P_t + (1-\gamma)(\log P_n - \log P_t)$

[2] This equation informs us how much of the inflation differential between non-tradable and tradable can be ascribed to the domestic BS effect.

Thus, aggregate inflation can be decomposed into the sum of inflation in the tradable sector and the weighted sectoral inflation differential that is the desired domestic BS effect: $(1-\gamma)(\log P_n - \log P_t)$[3], where $(1-\gamma)$ denotes the share of non-tradable in production.

The BS effect pinpoints some important economic implications, sometimes helpful even to the monetary authorities. Sinn and Reutter (2000) inquire a common monetary policy to result in price stability in all countries of the monetary union. They argue that the previous inflation targets set by the Bundesbank should not be adopted by the European Central Bank (ECB) because Europe's diversity in national productivity growth rates implies substantial relative price changes among the different countries. To allow for these changes without causing anyone country to deflate, the common monetary policy has to be looser than in the German case.

The magnitude of the BS effect is of considerable interest for policymakers in European Monetary Union (EMU) candidate countries and relevant European Union (EU) institutions. If the productivity growth differential between the traded and non-traded goods sectors is larger in an EMU candidate country than in the euro area, then overall inflation will be higher in that country. Assuming a fixed exchange rate regime, there is a strong possibility that the inflation criterion imposed by the treaty of Maastricht will not be achieved. This could happen if the BS effect was higher than 1.5 percentage points annually – permissible divergence of inflation rate in the candidate country from the average inflation rate in three best-performing member states of the EU, according to the Maastricht Treaty. Therefore, monetary authorities are coerced to implement a contractionary monetary policy to meet the inflation criterion, a case which could threaten economic growth targets. Under a floating exchange rate regime, it will result in a combination of higher inflation and appreciation of the nominal exchange rate. In both cases the real exchange rate will appreciate.

However, there is considerable debate concerning the extent to which the BS effect contributes to inflation differentials. Kovács and Simon (1998), Rother (2000), Halpern and Wyplosz (2001), Golinelli and Orsi (2002) show that real appreciation due to productivity differentials is approximately 3 per cent per year in a number of transition economies, whereas De Broeck and

[3] In contrast the international BS effect is $\log P - \log P^* = (1-\gamma)(\log P_n - \log P_t - \log P_n^* + \log P_t^*)$, where an asterisk denotes international variables.

Slok (2001), Corricelli and Jazbec (2001) and Égert (2002a and b) find considerably lower estimates of the BS effect, in particular ranging from 0 to 1.5 per cent per year.

This part of the study gauges the magnitude of the BS effect for Greece to determine the extent to which its inflation differential with the euro area is contingent on it.[4] Greece is a country that today has lower per capita income than most of the other European countries and therefore higher productivity in the tradable sector and its inflation is considerably above the euro area average, hence, it is worthwhile to evaluate the proportion of its inflation attributable to the BS effect.

We use data for the tradable and non-tradable sectors, which permits estimation of total factor productivity growth in both sectors. By doing so, we are able to determine the size of the BS effect and the proportion of inflation attributable to it. In particular, we employ data for the output in the tradable and non-tradable sectors along with sectoral data on gross fixed capital formation and employment. These series allow us to estimate sectoral TFP series for Greece.[5] In order to calculate TFP growth, we need estimates of labour and capital stock growth as well as the labour's share in both sectors. We estimate the capital stock using the perpetual inventory method and data on gross fixed capital formation for different sectors. As in Gibson and Malley (2008) we assume rates of depreciation of 10% in the tradeables and 4% in the nontradeables.

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[4] Pelagidis and Toay (2006) focus on 5 factors affecting expensiveness in Greece, namely the constraints imposed by the EMU, the adoption of the euro, seasonal effects on inflation, unemployment and the BS effect. They find that some expensiveness concerning non-tradable is attributed to the BS effect, though the magnitude of the effect is quite smaller than the impact inflicted by other factors, for example, strong seasonal effects and product markets rigidities.

Gibson and Malley (2008) also attempt to capture the magnitude of the BS effect for Greece. Rather than gauging the international BS effect, they prefer to calculate the domestic version of the BS effect directly, by using sectoral national accounts data which permits estimation of TFP growth for both sectors. They state that any particular estimate is contingent on the definition of the tradable sector and the assumption they make about labour shares. The general gist of their paper shows that the effect has been declining through time, probably because the per capita income differential between Greece and the rest of the world has been diminishing and the non-tradable sector has been catching up with the tradable.

[5] To be as consistent with theory as we can, contrary to most previous papers, we use total factor productivity differences between the 2 sectors instead of the relative labour productivity to estimate the BS effect

Labour productivity growth is quite different from TFP growth, an inference that justifies our option to use TFP growth instead of labour productivity growth.

A potential pitfall in our analysis is that we focus exclusively on the domestic version of the BS effect and we do not take into account the fact that the countries with which Greece trades may also be experiencing a BS effect. If Greece's main trading partners also experience large BS effects, then the international BS effect for Greece would be trivial. To disentangle that ambiguous argument, one should contemplate that the main trading partners of Greece in the euro area have higher per capita income than Greece and have been experiencing lower growth rates than Greece, hence the magnitude of the BS effect in these countries is likely to be trivial.

A major discrepancy concerning the calculation of the domestic BS effect is the definition of the tradable and non-tradable sectors. The existing literature does not offer a single unified method for classifying activities in the tradable and non-tradable sectors, although the share of exports in total production in a given activity (often 10% is taken as a borderline value) is widely accepted. In this paper we consider as tradables the following categories: agriculture (despite being susceptible to subsidies and administered prices-Bragoudakis and Moschos, 2000), mining and quarrying, manufacturing, transport and communications (due to the deregulation and more intense global competition), hotels and restaurants (even though a part of this sector is non-tradable) and financial intermediation and real estate. By contrast, we consider as non-tradable all services, excluding transport and communications, hotels and restaurants, financial intermediation and real estate.

The estimation of the following equation provides an estimate of the domestic version of the BS effect:

$$\Delta\log(P_n/P_t)_t = c + b_0\, \Delta\log(PROD_t/PROD_n)_t + b_1\, \Delta\log(P_n/P_t)_{t-1} + \varepsilon_t$$

where, P_n is the non-tradable (service) price index, P_t is the tradable (goods) price index, $PROD_t$ is TFP in the tradable sector and $PROD_n$ is TFP in the non-tradable sector. To allow for the possibility of a delayed pass-through of productivity effects on inflation differentials, productivity terms are lagged up to one year.

Data and the Empirical Framework

Data covers the period 1989 to 2006 on an annual basis. Data on labour and the capital stocks in all of the abovementioned sectors was also obtained. In addition, the corresponding disaggregated (sectoral) data was obtained for the CPI measure. Data for prices comes from the Datastream database. Price indices for both sectors are calculated as value weighted averages of sectoral price indices, where the weights used are the share of each sector's value added in total value added. Data for labour was obtained from the National Statistical Service of Greece (ESYE), while that of the capital stock comes from the Ministry of Economy and Finance. The capital stock series is constructed from sectoral data on gross fixed capital formation assuming perpetual inventories, hence: $K_t = (1-\delta)\ K_{t-1} + I_t$, where capital stock in each period is measured by the previous-period stock (net of depreciation) augmented with new investment flows. Consistent with previous results, the depreciation rate δ is assigned the value of 10% for the tradable sector and 4% for the non-tradable sector (Sideris and Zonzilos, 2005; Gibson and Malley, 2008), while an initial benchmark is computed as $K_{1989} = I_{1989} / (\delta + i)$, with i being the average logarithmic growth rate of investment in the sample period 1989-2006. Output, labour and capital for both tradable and non-tradable were estimated as a weighted average, with the weights being determined similarly as above. Finally, once again, we employ the RATS 6.1 software to serve the goals of our empirical analysis.

To construct the TFP (or PROD) measures we use the same Cobb-Douglas production functions as they were defined above:

$Y_t = A_t L_t^{a_t} K_t^{1-a_t}$ and $Y_n = A_n L_n^{a_n} K_n^{1-a_n}$

The residuals proxy TFP measures, i.e. the Solow residuals. Our TFP measure is constructed in the conventional way. It is constructed according to the following formula:

$(\Delta A_n)_t = (\Delta y_n)_t - \alpha\ (\Delta L_n)_t - (1-\alpha)\ (\Delta K_n)_t$ and $(\Delta A_t)_t = (\Delta y_t)_t - \alpha\ (\Delta L_t)_t - (1-\alpha)\ (\Delta K_t)_t$

where A represents the Solow residual (the TFP measure) or an index of Hicks-neutral technical progress, K is the capital input and L is the labour input (the Δ symbol denotes first-differences). Therefore, our priority is the estimation of the Cobb-Douglas production function for both types of goods in order to get estimates for α and (1-α) shares, e.g. labour and capital shares, respectively.

First, unit root tests are performed to identify the presence or not of any integration process for the series under investigation. We test for unit root nonstationarity by using the tests proposed by Dickey and Fuller (1981). In particular, the analysis is based on the augmented Dickey-Fuller unit root tests. The results are presented in Table 1. Using a 1% significance level, it is clear that the data is consistent with a unit root for all series. When first differences are used, unit root nonstationarity is rejected in all cases.

Table 1. Unit root tests

Variable	Levels		First Differences	
	Without Trend	With Trend	Without trend	With trend
Tradable				
Y	-0.73[3]	-1.33[3]	-4.11[2]*	-4.88[2]*
L	-0.66[4]	-0.95[4]	-4.29[2]*	-4.77[2]*
K	-0.30[3]	-1.47[3]	-5.11[2]*	-5.81[1]*
Non-tradable				
Y	-0.55[3]	-1.06[3]	-4.43[1]*	-4.79[1]*
L	-0.42[3]	-0.72[4]	-4.14[2]*	-4.54[1]*
K	-0.78[4]	-1.26[4]	-5.43[2]*	-5.95[1]*

Notes: Numbers in square brackets denote the optimal number of lags used in the augmentation of the test regression and it was obtained through the Akaike criterion. An asterisk indicates that the unit root null hypothesis is rejected at the 1% level.

Next, dynamic OLS estimates (Stock and Watson, 1993) are obtained (Table 2). These findings denote that the sum of the share parameters is statistically close to one for both the non-tradable and the tradable sectors, implying that the constant returns to scale technology assumption is accepted for both sectors. Moreover, the estimates of the labour share in both sectors are close to those reached by other studies (Gibson and Malley, 2008).

Table 2. Dynamic OLS estimates for Cobb-Douglas

	Tradable	Non-tradable
constant	0.459	0.516
	(0.356)	(0.369)
α	0.647	0.583
	(0.062)*	(0.071)*
1-α	0.314	0.369
	(0.122)*	(0.086)*
R^2	0.68	0.73
H_0: α + (1-α) = 1	$x^2(1)$= 0.0845	0.0763
	[p-value]= 0.56	0.72

Notes: Figures in parentheses denote robust standard errors (Newey and West errors). The number of leads and lags in the DOLS regression is equal to four.
* denotes that the coefficient is significant at the 1% critical level.

Once we obtain the parameter shares estimates from above, then through the definition of TFP, the calculation yield the values for TFP in both sectors, which in turn will be used in the BS estimation regression. The BS results are reported in Table 3. The empirical findings display that the estimated parameter on the productivity growth differential is positive and statistically significant different from zero. This provides clear evidence in favour of the BS effect. In other words, faster productivity growth in tradable vis-à-vis the non-tradable sector, can explain a substantial percentage of the difference in inflation rates between the two sectors under investigation.

In particular, a percentage point increase in the productivity differential is associated with an substantial increase in the inflation differential of about one and a half percentage point. In other words, according to the BS effect, differential productivity growth results in about one and a half percentage point higher inflation.

Table 3. Estimated coefficients and accompanying t-statistics for the domestic Balassa-Samuelson effect.

Independent variables	***Dependent variable*** $\Delta \log \left(\frac{CPI_n}{CPI_t} \right)_t$
C	0.743(3.21)*
$\Delta \log \left(\frac{PROD_t}{PROD_n} \right)_t$	0.758(4.59)*
$\Delta \log \left(\frac{CPI_n}{CPI_t} \right)_{t-1}$	0.728(4.11)*
R^2	0.63
BS Effect	1**.482**

Notes: Figures in parentheses denote t-statistics, while an asterisk shows significance at 1%. The BS effect was calculated as b_0 times average productivity differentials over the sample period.

Discussion

The empirical results in this chapter reached the conclusion that the magnitude of the domestic Balassa-Samuelson effect is statistically significant. These findings are of considerable interest for domestic policymakers as well as for domestic relevant institutions. In addition, the large size of this effect indicates strong persistence of relative price changes, especially in the sector of tradable goods; the latter fact could be the primary reason for balance of payments disequilibria and, therefore, one of the reasons for the persistent worsening of balance of payments deficits. Given the fact that in Greece productivity increases were higher in manufacturing than in services while, at the same time, unit labour costs exceeded productivity measures in both sectors, then service prices could be higher than those in manufacturing. Therefore, productivity measures require relatively declining prices in the tradable sector, something that did not really occur given the low competitiveness of the country. This could be due to the fact that productivity gains in the tradable goods sector should be accompanied by rising wages, as sectoral wages should equal sectoral marginal products of labour. Such rising wages seem to be spent on both tradable and nontradable goods, with the latter not facing any competition from abroad. Although the lower productivity in the services sector, it seems that the increased demand (both from domestic and EU incentives) is not counterbalanced by a rise in quantity or quality of offered services, resulting in higher priced services as well. Rising wages also intensify inflation pressure in the nontradable sector, deteriorating the international competitiveness of the Greek economy.

Concluding Remarks and Policy Implications

In general, the estimations of the BS effect are really important mainly for their policy implications. The main conclusion emerging from the above analysis is that the domestic Balassa-Samuelson effect is present for the case of Greece. Thus, claims that the BS effect is a significant determinant of inflation in this country seems to strongly hold. What are the policy implications of the above results? If the BS effect is present, as in our case, then productivity differentials between these two sectors in the Greek case seem to have a substantial positive effect on inflation. In such a case, these productivity differentials seem incapable of affecting relative competitiveness between the two sectors and, to a great likelihood, will disappear when real convergence between them will be achieved.

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