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THE IMPACT OF ECONOMIC UNCERTAINTY AND INFLATION UNCERTAINTY ON THE GREEK ECONOMY

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ABSTRACT

We provide estimates of economic uncertainty and inflation uncertainty for the Greek economy, and consider their time-varying impact on the corresponding macroeconomic variables, i.e. GDP growth and inflation. We find that, in both cases, the degree of uncertainty varies over time. Its impact on the underlying variable also fluctuates and is statistically significant and negative during both the global financial crisis and the Greek sovereign debt crisis, as well as during the COVID-19 pandemic. Thus, during these periods, uncertainty weighs on the economy's fundamentals. Our findings have a number of policy implications, including that the extraordinary policy measures taken to contain the economic impact of the COVID-19 pandemic should be withdrawn gradually and with due caution, as any increase in uncertainty may have an adverse effect on economic activity and a deflationary impact on prices.

Keywords: stochastic volatility; time-varying parameters; financial crisis; COVID-19 pandemic

JEL classification: C11; C22; E31; E32

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ΟΙ ΕΠΙΠΤΩΣΕΙΣ ΤΗΣ ΟΙΚΟΝΟΜΙΚΗΣ ΑΒΕΒΑΙΟΤΗΤΑΣ ΚΑΙ ΤΗΣ ΑΒΕΒΑΙΟΤΗΤΑΣ ΓΙΑ ΤΟΝ ΠΛΗΘΩΡΙΣΜΟ ΣΤΗΝ ΕΛΛΗΝΙΚΗ ΟΙΚΟΝΟΜΙΑ

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ΠΕΡΙΛΗΨΗ

Στο άρθρο παρουσιάζονται οικονομετρικές εκτιμήσεις για την οικονομική αβεβαιότητα και την αβεβαιότητα σχετικά με τον πληθωρισμό στην ελληνική οικονομία και εξετάζεται κατά περίπτωση η χρονικά μεταβαλλόμενη επίδραση της εκτιμώμενης αβεβαιότητας στην αντίστοιχη μακροοικονομική μεταβλητή, δηλαδή το ρυθμό οικονομικής ανάπτυξης και τον πληθωρισμό. Βρίσκουμε ότι η εκτιμώμενη αβεβαιότητα εμφανίζει, και στις δύο περιπτώσεις, σημαντική μεταβλητότητα κατά τη διάρκεια του δείγματος. Επιπλέον, η επίδραση της αβεβαιότητας στην αντίστοιχη μακροοικονομική μεταβλητή επίσης μεταβάλλεται διαχρονικά και είναι, κατά περιόδους, στατιστικά σημαντική. Μεταξύ άλλων, εκτιμάται ότι η επίδραση της αβεβαιότητας στο ρυθμό οικονομικής ανάπτυξης και τον πληθωρισμό είναι αρνητική και στατιστικά σημαντική κατά τη διάρκεια τόσο της παγκόσμιας χρηματοπιστωτικής κρίσης και της ελληνικής κρίσης δημόσιου χρέους όσο και της πανδημίας COVID-19. Δηλαδή σε αυτές τις περιόδους η αβεβαιότητα επιδεινώνει τα θεμελιώδη μεγέθη της ελληνικής οικονομίας. Από τα ευρήματα της μελέτης προκύπτουν συμπεράσματα χρήσιμα για την άσκηση πολιτικής, μεταξύ των οποίων και ότι η διαδικασία απόσυρσης των έκτακτων μέτρων κρατικής στήριξης που υιοθετήθηκαν κατά την πανδημία ενδείκνυται να είναι σταδιακή και προσεκτική, καθώς τυχόν περαιτέρω αύξηση της αβεβαιότητας ίσως έχει αρνητική επίδραση στην οικονομική δραστηριότητα και τον πληθωρισμό.

THE IMPACT OF ECONOMIC UNCERTAINTY AND INFLATION UNCERTAINTY ON THE GREEK ECONOMY

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I INTRODUCTION

Policymakers routinely monitor key macroeconomic variables, such as inflation and GDP growth, in order to gauge which phase of the cycle the economy is in and set policy accordingly. They also consider the degree of uncertainty surrounding the outlook for these variables, as it may have both real and nominal effects. Such effects can vary over time, both qualitatively and quantitatively, and may be of particular concern during periods of stress such as the global financial crisis or the COVID-19 pandemic.

Indeed, the pandemic has triggered an increase in economic uncertainty, which permeates all facets of economic activity. Uncertainty surrounds the length and intensity of the pandemic as well as the duration, nature and severity of its economic consequences. An increase in economic uncertainty affects the decisions of households and firms, which are based on their forward-looking expectations of the economy's trajectory. First, due to the pandemic and the ensuing containment measures, future labour income flows are rendered uncertain, while firms' assessment of future demand for their goods and services is also called into question. Moreover, economic uncertainty forces entrepreneurs and investors to re-assess the viability of their investment plans and possibly to postpone or cancel some of them. Thus, uncertainty *per se* can have a substantial negative impact on economic activity. There is however also the view that, under certain circumstances, an increase in economic uncertainty can lead to the pursuit of riskier investment projects which offer higher expected returns, thus boosting the rate of economic growth.

On the nominal side, the COVID-19-induced decline in economic activity exerted deflationary pressures which brought the rate of inflation once again into negative territory. Additionally, the degree of uncertainty regarding the future trajectory of inflation increased, as reflected *inter alia* in survey responses.[1] Just as an increase in economic uncertainty affects agents' decisions, with potentially adverse implications for economic activity, heightened uncertainty regarding the path of inflation is a hindrance to monetary policymaking, potentially reducing its effectiveness to the extent that it may directly affect the level of inflation.

An increase in inflation uncertainty during the pandemic could reflect opposing economic forces at play. Households and firms have drastically reduced their consumption, as a result of the sharp income decline seen in many sectors as well as of the difficulty to spend posed by the social distancing measures. Savings have increased in tandem, partly for precautionary purposes, with a deflationary effect. On the other hand, there are mounting concerns that the adoption of numerous extraordinary fiscal and monetary policy measures to provide support during the pandemic will prompt inflationary pressures once the economy gradually starts recovering. Thus, the question arises as to whether inflation uncertainty may affect the level of inflation itself and, if so, via which mechanism.

In this paper we provide time-varying estimates of two types of uncertainty for the Greek economy, namely real (economic) uncertainty and inflation uncertainty, and consider their impact

1 See the speech by Fabio Panetta, 1.7.2020 (https://www.ecb.europa.eu/press/key/date/2020/html/ecb.sp200701.en.html).

on the underlying macroeconomic variables, i.e. GDP growth and inflation. We find that, in both cases, the degree of uncertainty fluctuates over time. Moreover, its impact on the corresponding variable also varies and has been significant during certain periods. In particular, it seems to have been both statistically significant and negative during the COVID-19 pandemic, acting as a drag on the Greek economy's fundamentals. Our findings have a number of policy implications, not least that the extraordinary policy measures taken to contain the economic fallout of the COVID-19 pandemic should be lifted gradually and with due caution, as any rise in uncertainty may have an adverse effect on economic activity and a deflationary impact on prices, at a time when both variables' sensitivity to uncertainty is heightened and significant.

The remainder of this paper is structured as follows: Section 2 provides a literature review. Section 3 describes the data and econometric methodology employed. Section 4 presents and discusses the findings about the relationship between (i) real economic uncertainty and GDP growth and (ii) inflation uncertainty and inflation. Section 5 provides some policy implications and conclusions.

2 LITERATURE REVIEW

2.1 REAL ECONOMIC UNCERTAINTY AND GDP GROWTH

The question of how economic uncertainty may affect real economic activity has been repeatedly explored in the relevant academic literature. There are arguments both ways. In early work, Sandmo (1970) and Black (1987) argue that increased real uncertainty will raise average economic growth. For Sandmo (1970), the effect works through precautionary balances. Increased uncertainty generates incentives to hold higher precautionary savings, which, within a simple Solow growth model, will increase growth. Black (1987) starts from the positive relationship between risk and return in a portfolio model, and suggests that increased uncertainty may encourage greater investment in riskier projects. Such projects have higher mean returns, thus boosting real output growth on average, but they come at the cost of rendering output growth more volatile. There is also the view that uncertainty may, under certain circumstances, stimulate R&D. Faced with a more uncertain future, some firms may have a stronger incentive to innovate, which could potentially have a positive effect on long-run growth (see for example Lee 2016).

Conversely, Pindyck (1991) suggests that, if output becomes more variable and uncertainty increases, investment and hence growth will decline. The rationale is that, as investment is usually irreversible, heightened uncertainty will cause entrepreneurs to put off investments, thus slowing growth. Similar arguments are later formalised within richer general equilibrium models – see for example the influential work by Bloom et al. (2007). Blackburn and Pelloni (2005) generate the same result from an endogenous growth model, where increases in real uncertainty cause workers to react by setting higher wages, thereby lowering employment, investment and growth.

The experience of the global financial crisis provides support to the latter of the two effects, as reflected in recent research. Fajgelbaum et al. (2017) and Bloom et al. (2018) among others propose models in which economic uncertainty can have a detrimental effect on economic activity by altering investment decisions. Samaniego and Sun (2019) and Arata et al. (2017) further explore the role of investment lumpiness and irreversibility and show, both theoretically and empirically, that it implies slow growth in times of high uncertainty. Basu and Bundick (2017) and Leduc and Liu (2016) develop models in which the impact of economic uncertainty on economic activity works through search frictions and sticky prices, while Nakata (2017) also builds a sticky price model to show that the effects of uncertainty are substantially worse at the zero

lower bound (ZLB). Finally, Bianchi et al. (2018) distinctly model demand- and supply-side uncertainty and show that, while both cause contractions in real activity, supply-side uncertainty takes a greater toll on investment.

As regards the empirical evidence, the first effect seems to dominate in early work. Kormendi and Meguire (1986) study 47 countries for the post-war period and find that economic uncertainty has a positive and statistically significant effect on economic growth. Grier and Tullock (1989) study an even larger dataset and draw the same conclusion, as do Caporale and McKiernan (1996) for the UK and Fountas et al. (2006) for the G7. Subsequent empirical evidence, however, weighs mostly in favour of the opposite effect, i.e. that economic uncertainty dampens growth. Ramey and Ramey (1995) first report significant negative effects for a large sample of countries. Kneller and Young (2001) report the same for OECD countries. See also Bredin and Fountas (2009) for EU countries up to 2003 for similar findings. In the case of Greece, the question has been explored by Chapsa et al. (2011), Gibson and Balfoussia (2010) and Tsouma (2014), who, by and large, find that economic uncertainty negatively affects economic activity.

Recent work focuses on possible regime dependence and non-linearities. Martin and Rogers (2000) show that a country's stage of development may matter, as they find a negative and significant effect for more advanced economies but no significant effect for developing countries. Using 50 years of data on the G7, Neanidis and Savva (2013) find that uncertainty regarding output growth is related with a higher average growth rate mostly in a low-growth regime. Conversely, Bredin et al. (2021) exploit a centuries-long sample of UK data and report that low-growth regimes are associated with a negative effect of uncertainty on growth, while medium- or high-growth regimes are associated with a positive effect. Christou et al. (2020) also study 150 years of UK data and find a negative effect, the strength of which exhibits substantial time-variation. Jovanovic and Ma (2020) document that higher uncertainty is associated with a more dispersed and negatively skewed distribution of output growth, while the response of economic growth to an increase in uncertainty is non-linear and asymmetrical. Angelini et al. (2019) show that, in the United States, uncertainty generates a decline in economic activity, and the effect is amplified during periods of economic and financial turmoil. Similarly, Alessandri and Mumtaz (2019) estimate that the recessionary effect of uncertainty shocks in the United States is six times larger when the economy is going through a financial crisis. Finally, a strand of recent research studies the impact of uncertainty shocks when the economy is at the zero lower bound, and finds that their contractionary effect is significantly larger (see for example Caggiano et al. 2017 and Plante et al. 2018).

2.2 INFLATION UNCERTAINTY AND INFLATION

As regards inflation uncertainty, its relationship with the level of inflation is more nuanced. Uncertainty about future inflation is generally thought to distort the relative-price mechanism, leading to a misallocation of resources and thus lower growth. An early attempt to explain this was made by Lucas (1973). In his model, unanticipated inflation causes economic agents to mistake general price increases for relative price changes and to make inappropriate economic decisions in response. In this context, unpredictable inflation is costly, as prices no longer reflect underlying real changes in the economy, which would in turn warrant a change in the allocation of resources, or investment in one sector rather than another. The question then arises as to whether inflation uncertainty is somehow connected to the actual level of inflation.

Several, often contradictory, theoretical arguments can be found in the academic literature regarding the possible direction of a causal relationship between inflation and inflation uncertainty. There is extensive evidence that countries with high rates of inflation are also likely to experience high inflation variability as

well as growth and welfare losses – see Friedman's 1977 Nobel lecture for a first explanation of this phenomenon, which was later formalised by Ball (1992) as a game of information asymmetries between the monetary authority and the public. This line of argument, i.e. that inflation causes inflation uncertainty and that its costs (in terms of economic activity) also materialise through the uncertainty channel, is often referred to in the literature as the Friedman-Ball hypothesis.

Another strand of the academic literature pursues the idea that causality may run in the opposite direction, i.e. that in fact it is greater inflation uncertainty that causes higher average inflation. This possibility has been formalised as a feature of models based on the Barro-Gordon framework. Seminal among this body of work is that by Cukierman and Meltzer (1986) and Cukierman (1992), in whose model low policy credibility, an ambiguity of objectives and poor monetary control on behalf of policymakers increase the average rate of inflation. The monetary authority has a dual mandate: to contain inflation and to promote economic growth. However, there is a trade-off between the two objectives and there is no commitment mechanism. The monetary authority has an incentive to create monetary surprises —i.e. to generate inflation uncertainty— in an effort to stimulate economic growth; this in turn leads to increases in the level of inflation. The money supply process is also assumed to have a random component, due to the monetary authority's inability to discern which is the most appropriate monetary policy instrument and to precisely control it. Therefore, not only are economic agents uncertain about the level of future inflation but also they have no way of inferring whether an increase in the observed level of inflation is due to a random money supply disturbance or to a shift in policymakers' emphasis on unemployment. In this context, higher inflation uncertainty leads to higher inflation and suggests an "opportunistic" or "myopic" central bank, according to the Cukierman-Meltzer hypothesis.

It is not only the direction of causality that is questioned —that is, whether it is inflation that drives inflation uncertainty, or vice versa— but also the sign. In both the Friedman-Ball and the Cuckierman-Meltzer hypotheses, higher inflation is associated with higher inflation uncertainty. Following a different thread, Holland (1995) proposes that, if the Friedman-Ball hypothesis is valid, there may also be a secondary feedback effect from inflation uncertainty back to inflation, as a result of policymakers' stabilisation efforts. As inflation uncertainty rises due to increasing inflation, there is an increased incentive for policymakers to respond by contracting money supply growth, so as to contain inflation in order to reduce inflation uncertainty and the associated negative real output and welfare effects. Thus, a negative causal effect of inflation uncertainty on inflation points to what is known as the "stabilisation motive" of the monetary authority, which views inflation uncertainty as a welfare cost. As a result, higher inflation uncertainty lowers inflation because of the monetary authority's response.[2]

The different hypotheses on the link between inflation and inflation uncertainty have given rise to a large empirical literature. Here we focus mostly on the strand which explores the impact of inflation uncertainty on inflation, in line with our empirical approach. In a much-cited seminal empirical study, Grier and Perry (1998) use a GARCH-M specification to explore this relationship for the G7 countries in the period 1948-1993. They report that higher inflation significantly raises inflation uncertainty in all countries. As regards the reverse causal relationship, increased inflation uncertainty appears to lower inflation in the United States, the UK and Germany in line with Holland's concept of the monetary authority's "stabilisation motive", while it

2 There is also a final line of argument, according to which it is inflation that causes inflation uncertainty but, in contrast with the Friedman-Ball theory, higher inflation reduces inflation uncertainty. Pourgerami and Maskus (1987) and Ungar and Zilberfarb (1993) argue that as inflation increases, agents invest more resources in forecasting inflation, which, in theory at least, reduces inflation uncertainty. However, there is little evidence in support of this hypothesis.

raises inflation in Japan and France, as predicted by the Cukierman-Meltzer model of "opportunistic" central bank behaviour. Notably, the authors note that these differential responses to inflation uncertainty are correlated with Cukierman's (1992) ratings of central bank independence, with Japan and France ranking as less independent than the rest. Numerous studies followed suit, employing similar ARCH-type techniques to explore the relationship. Apergis (2004) among others finds evidence of both the Friedman-Ball and the Cukierman-Meltzer hypotheses for the G7 economies. In a more recent study of the G7, Neanidis and Savva (2013) find that the effect of inflation uncertainty on inflation is typically positive, especially during inflationary periods. Fountas et al. (2004) consider six major EU countries and report Friedman-Ball effects in all of them, while increased inflation uncertainty lowers inflation in Germany and the Netherlands and raises it in Italy, Spain and France. Karanasos and Schurer (2008) study Sweden, Germany and the Netherlands and find a negative impact of inflation uncertainty on inflation for Sweden, in line with the Holland hypothesis, whereas the opposite holds for Germany and the Netherlands, in line with the Cukierman-Meltzer hypothesis. Finally, Živkov et al. (2014) confirm both hypotheses for the largest Eastern European countries (EEC) with flexible exchange rates, but reject them for smaller, open EEC economies with a fixed exchange rate regime.

Stepping away from the ARCH tradition, Bhar and Hamori (2004) use a Markov switching model to examine inflation uncertainty at different horizons and find that high uncertainty about long-run inflation is associated with an increase in inflation for Canada, Germany and Japan, while high uncertainty about short-run inflation is associated with an increase in inflation for Germany and the United States, but with a decrease in inflation for Canada. Berument et al. (2009) use a stochastic volatility in mean model for the United States and find strong evidence that shocks to inflation volatility increase inflation persistently. In a more recent paper on the United States, Bredin and Fountas (2018) use two centuries of data and find that, since its establishment, the US Federal Reserve (Fed) has responded to increasing inflation uncertainty in a stabilising manner, in line with the Holland hypothesis. In a panel set-up, Kim and Lin (2012) estimate a system of simultaneous equations using data for 105 countries over the period 1960-2007 and find a two-way interaction between inflation and its variability that is consistent with the Friedman-Ball and Cukierman-Meltzer theories, and robust to alternative model specifications, time periods and country-specific characteristics. More recently, Barnett et al. (2020) construct a time-varying stochastic volatility measure of inflation uncertainty for the United States, the UK, the euro area, China and South Africa, and confirm that causality between the two variables is not time-invariant, with inflation lagging in some cases and time periods and leading in others.

Finally, a number of papers find that specific policy or regime shifts may be associated with a halt or a reversal of a previously detected relationship. For example, Neanidis and Savva (2011) study new EU Member States and candidate countries and find that uncertainty positively affects inflation in the pre-EU accession period, but not during EU accession and following entry. Conversely, Balfoussia and Gibson (2010) find evidence of Friedman-Ball effects in the case of Greece prior to EMU convergence, but not after the adoption of the euro. Finally, for the euro area, Caporale et al. (2012) also find a structural break in the inflation-inflation uncertainty relationship, coinciding with the introduction of the euro, which is associated with a reversal of causality, pointing towards Friedman-Ball effects in the EMU era.

In summary, the empirical evidence paints a rather mixed picture. While there is evidence supporting the Friedman-Ball hypothesis, the same is also true for the Cukierman-Meltzer and Holland hypotheses, according to which it is inflation uncertainty that affects the level of inflation either positively or negatively. Most

importantly, the literature clearly illustrates that the relationship between the two variables varies over time in terms of direction, sign and significance of the effect, thus highlighting the empirical relevance of time-varying parameter models, as proposed by Chan (2017). With this in mind, we explore the relationship for Greece using a time-varying parameter framework, in order to detect and understand any such changes.

3 ECONOMETRIC METHODOLOGY AND DATA

Uncertainty is not directly measurable; it is typically proxied for by alternative metrics. For example, in the case of economic uncertainty these may include the economic sentiment indicator and its sub-indices, or uncertainty indicators based on textual analysis of economic articles published in the daily press (see e.g. Hardouvelis et al. 2018). Such indices occasionally track each other closely but do not, in general, exhibit a high degree of correlation. Moreover, it is preferable, if possible, to directly estimate the degree of uncertainty associated with a variable from the underlying data. This is the approach we adopt in this paper.

We employ a time-varying parameter stochastic volatility in mean (TVP-SVM) model to estimate the stochastic volatility of each of the two variables in question, i.e. real GDP growth and inflation. The model allows us to explore the impact of the estimate of each variable's uncertainty on the level of the variable itself, over different periods of time. For instance, in the case of economic uncertainty, the model estimates the stochastic volatility of economic growth, which is contemporaneously used as an explanatory variable driving economic growth itself. Thus, it is possible to study the effect of economic uncertainty on economic activity over time. We proceed similarly in the case of inflation uncertainty and inflation.

The TVP-SVM model employed in this paper is an extension of that developed by Chan (2017). In particular, assuming that y_t, where $t=1,...,T$, is the variable of interest, i.e. the rate of either real GDP growth or inflation, then the model is specified as follows:

$$y_t=c_t+\beta_{1,t}y_{t-1}+\beta_{2,t}y_{t-2}+a_t e^{h_t}+\varepsilon_{y,t}, \quad (1)$$
$$\text{with } \varepsilon_{y,t}\sim N(0,\ e^{h_t})$$

$$h_t=\mu+\varphi(h_t-\mu)+by_{t-1}+\varepsilon_{h,t}, \quad (2)$$
$$\text{with } \varepsilon_{h,t}\sim N(0,\ \sigma_h^2)$$

$$\gamma_t=\gamma_{t-1}+\varepsilon_{\gamma,t},\ \text{ with } \varepsilon_{\gamma,t}\sim N(0,\ \boldsymbol{\Omega}) \quad (3)$$

The mean equation in (1) is a time-varying autoregressive model with two lags, AR(2), which allows for a possible volatility feedback, i.e. volatility may have an impact on the level of variable y_t. Obviously, the subscript t implies that all parameters change over time, capturing potential structural changes in the unconditional mean, c_t, the autoregressive parameters, $\beta_{1,t}$, $\beta_{2,t}$, and the volatility sensitivity parameter a_t. The errors of the process, $\varepsilon_{y,t}$, are distributed as normal with time-varying stochastic volatility, e^{h_t}. For the logarithmic stochastic volatility, h_t, in (2) we use an AR(1) process and we also allow for the lagged dependent variable to affect the current volatility via parameter b. The time-varying parameters are gathered in vector γ_t, $\gamma_t=(c_t,\beta_{1,t},\beta_{2,t},a_t)'$ which follows a driftless random walk process with $\boldsymbol{\Omega}$ being the 4×4 covariance matrix as shown in (3). The model is estimated with Bayesian methods using the algorithm and the elicitation of the prior distributions proposed by Chan (2017).[3]

For our empirical analysis, we use the Gross Domestic Product (GDP) as a measure of economic activity and the Harmonised Index of Consumer Prices (HICP) as a measure of the price level. For both measures we use quarterly, seasonally adjusted, annualised percentage changes, i.e. $y_t=400\times\ln(p_t/p_{t-1})$ where p_t is the quarterly GDP and HICP, respectively. Note that in the Appendix we also provide

3 The readers are referred to Chan (2017) for further estimation details.

empirical results using alternative price indices, as a robustness check. All the data used in this article were downloaded from the Hellenic Statistical Authority (ELSTAT) website.[4] As ELSTAT publishes all price indices at a monthly frequency and seasonally unadjusted, we use the Tramo-Seats method to account for the seasonality of the monthly price indices and then we take a three-month average to compute a quarterly index. The sample covers a 25-year period spanning from 1995Q1 (1996Q1 for HICP) to 2021Q1. It includes all phases of the Greek business cycle and several periods of increased volatility.

4 EMPIRICAL FINDINGS

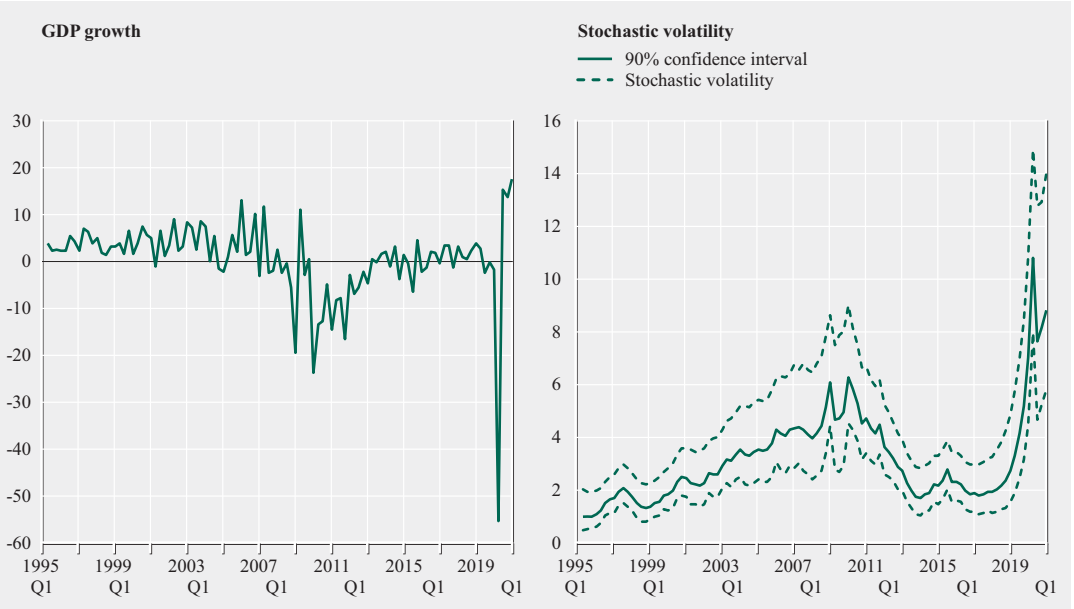
4.1 ECONOMIC UNCERTAINTY AND GDP GROWTH

All estimates are presented in graphical form. Chart 1 shows the rate of change in GDP on the left-hand scale and our estimates of economic uncertainty with the corresponding confidence bands on the right-hand scale. The estimated economic uncertainty varies substantially over time. We first trace a short period of somewhat elevated uncertainty prior to Greece's entry into the European exchange rate mechanism (ERM) in 1998. Once Greece joins the ERM, economic uncertainty temporarily subsides. The estimates then point towards a gradual but protracted increase in economic uncertainty throughout the 2000s, especially in the second half of the decade, whose peak coincides with the global financial crisis in 2008 and the subsequent sovereign debt crisis. Afterwards, a gradual easing of uncertainty is observed, followed by a second period of relative increase, which culminates in 2015Q3 with the imposition of capital controls. Economic uncertainty then subsides again, as the Greek economy gradually returns to positive growth rates. However, this trend is abruptly interrupted as the outbreak of the COVID-19 pandemic leads to an unprecedented surge in economic uncertainty, reaching in 2020Q2 levels higher than those

4 https://www.statistics.gr.

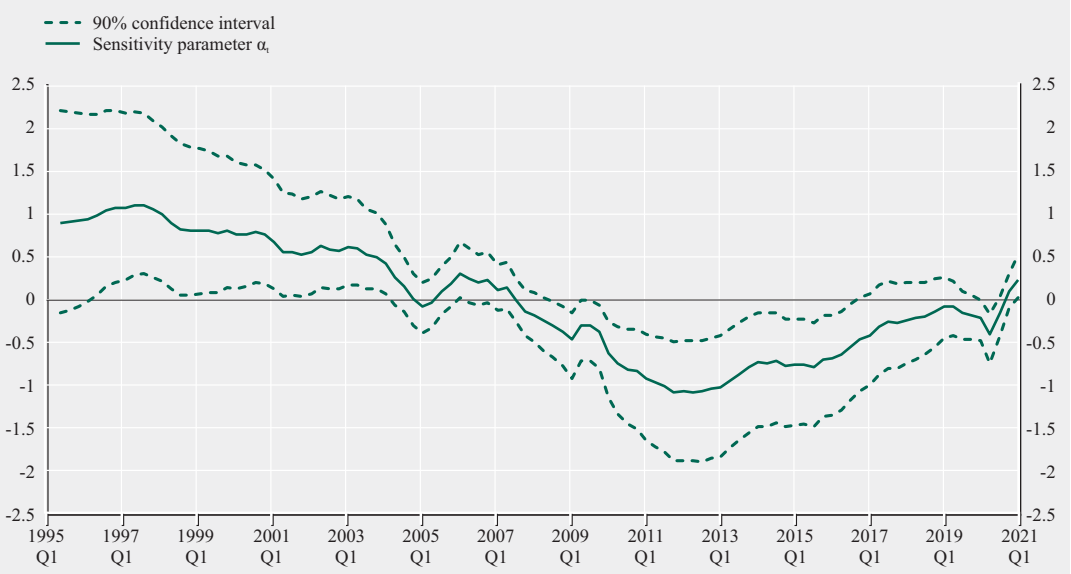
Chart 1 Economic activity and economic uncertainty (1995Q2-2021Q1)

(%)



Sources: ELSTAT and Bank of Greece estimations.

Chart 2 Time-varying coefficient, α_t, of economic activity's sensitivity to changes in economic uncertainty (GDP)
(1995Q2-2021Q1)



Sources: Bank of Greece estimations.

recorded during the financial crisis. Uncertainty declines somewhat in the following two quarters, possibly as a result of the fast adoption and implementation of containment measures and their economic impact, to rebound once again in 2021Q1. Overall, uncertainty remains substantially elevated compared with its pre-pandemic levels until the end of the sample.

Chart 2 presents the evolution of the time-varying coefficient a_t, which captures economic activity's sensitivity to changes in economic uncertainty. This estimated parameter captures how the prevailing level of economic uncertainty affects GDP growth at different points in time. It exhibits significant time-variation over the sample period. The effect of economic uncertainty on GDP growth is positive and mostly statistically significant up until 2007, in line with the theoretical arguments of Sandmo (1970) and Black (1987) and previous empirical evidence by Balfoussia and Gibson (2010). Thereafter, the effect is negative and statistically significant up until end-2016 and then again during the outbreak of the COVID-19 pandemic in Greece in 2020Q1, when strict social distancing measures were implemented, drastically limiting economic activity and travel. The coefficient takes its smallest negative values during the sovereign debt crisis, implying an increasing adverse effect of uncertainty on economic activity, and peaks at about the time of the PSI in 2012. It then declines in absolute value, only to increase again during the pandemic. In sum, our estimates reveal a structural break in the way economic activity depends on economic uncertainty: from the global financial crisis onwards economic uncertainty negatively affects economic activity, while the opposite is the case during the earlier part of the sample. The tracing of the financial crisis as a turning point is in line with our broader understanding of economic developments in Greece. Moreover, our findings echo those of Angelini et al. (2019), Alessandri and Mumtaz (2019), Caggiano et al. (2017) and others who find that the adverse effect of uncertainty on economic activity is amplified during periods of financial turmoil and when

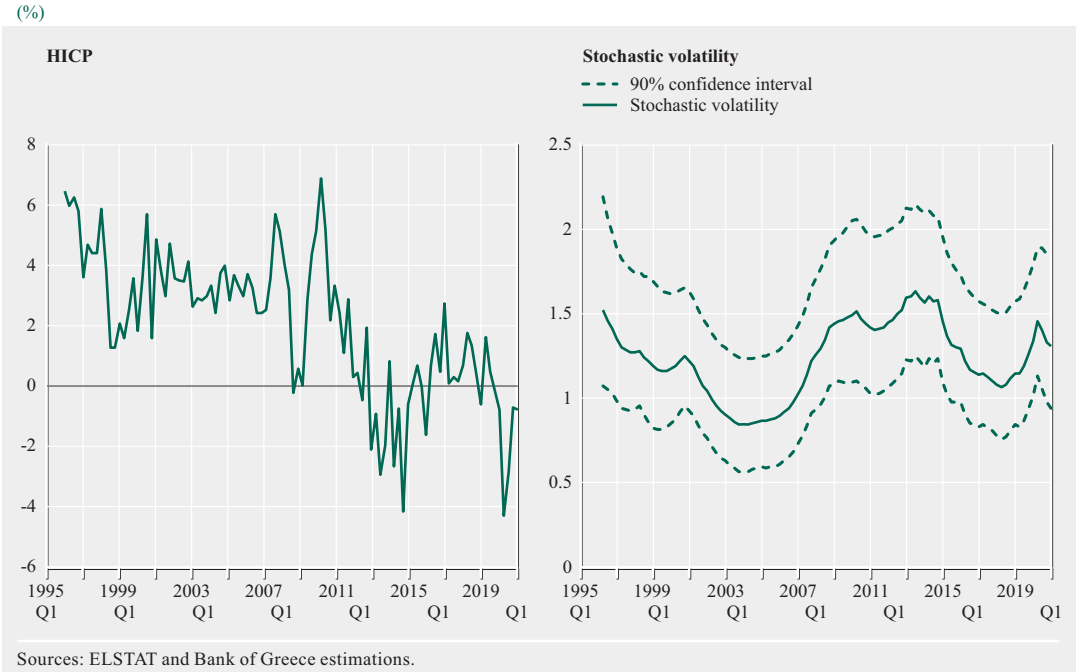
at the zero lower bound. As regards recent events, our estimates indicate that the sharp spike in economic uncertainty during the COVID-19 pandemic may have significantly contributed to halting the previous positive growth trajectory of the Greek economy. Following the adoption of targeted fiscal and monetary policy measures to support households and firms, the effect of economic uncertainty becomes insignificant in 2020Q4. The coefficient moves into positive territory towards the end of our sample, possibly indicating the start of a positive growth period, during which economic uncertainty could have a positive impact on economic activity.

4.2 INFLATION UNCERTAINTY AND HICP GROWTH

Turning to inflation uncertainty, the corresponding data and estimates are depicted in Charts 3 and 4. Uncertainty regarding inflation is high prior to EMU membership. It then declines and remains low for several years, arguably reflecting the beneficial effect of joining a monetary union with a credible monetary authority which targets inflation. Inflation uncertainty then rises again substantially during the global financial crisis and the Greek sovereign debt crisis, reaches its highest levels in 2013-14 and remains elevated during much of 2015. It subsequently steadily declines, as the Greek economy gradually begins to record positive rates of economic growth and inflation. This positive momentum is halted by the outbreak of the COVID-19 pandemic, which prompts a new spike in inflation uncertainty. A relative decline in uncertainty follows during the last two quarters of our sample.

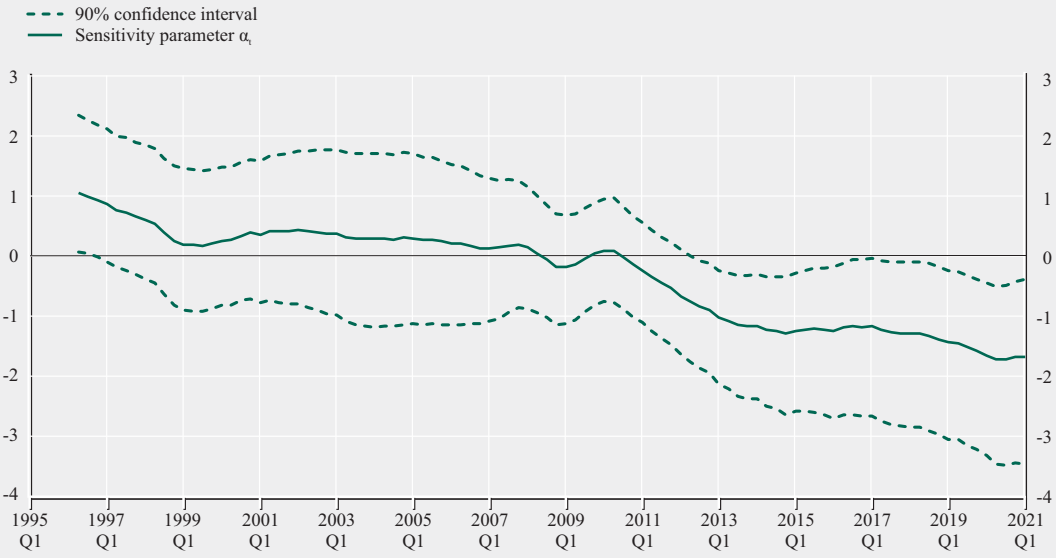
The estimated coefficient of inflation's sensitivity, a_t,to changes in inflation uncertainty is plotted in Chart 4. Its trajectory is highly time-varying and, as in the case of economic uncertainty, a clear structural break emerges. The impact of inflation uncertainty on inflation is briefly significant and positive at the beginning of the sample, indicating that, prior to Greece's EMU convergence process, the relatively high degree of uncertainty surrounding inflation

Chart 3 Inflation and inflation uncertainty (HICP) (1996Q2-2021Q1)



Sources: ELSTAT and Bank of Greece estimations.

Chart 4 Time-varying coefficient, α_t, of inflation's sensitivity to changes in inflation uncertainty (HICP) (1996Q2-2021Q1)



Sources: Bank of Greece estimations.

generated significant inflationary pressures, in line with the Cukierman-Meltzer hypothesis. The coefficient of sensitivity remains positive but is insignificant from 1997 onwards, up until the financial crisis. The relationship between the two variables then undergoes a structural change: the estimated coefficient a_t becomes negative, indicating that inflation uncertainty now exerts a deflationary pressure on prices. Moreover, the sensitivity coefficient is clearly statistically significant from 2012Q3 onwards, up until the end of the sample, including the period of the COVID-19 pandemic, in line with some of the results reported by Barnett et al. (2020). In other words, throughout the last decade of the sample, inflation uncertainty has a significant and negative impact on the level of inflation. Moreover, the value of the estimated coefficient is increasing in absolute value, thus this effect becomes increasingly strong. Inflation uncertainty seems to have the greatest deflationary impact during the COVID-19 pandemic. It is worth noting that the abovementioned empirical findings are quite robust under alternative measures of inflation such as the GDP price deflator, the Consumer Price Index (CPI) and the core CPI. The corresponding empirical results are presented in Charts A1 to A6 in the Appendix.

Our findings could suggest that, in the post-crisis low or negative inflation environment, where the zero lower bound is binding, higher inflation uncertainty predominantly reflects higher downside risks, i.e. a heightened prospect of further deflation, rather than a greater probability of inflation rebounding into positive territory. The exact economic mechanism through which the adverse impact comes about is unclear and, to our knowledge, has not, to date, been studied within a theoretical model.[5] However, it is likely that it works through expectations. When faced with the downside risk of protracted deflation, consumers and firms may act in a way that accentuates that risk, i.e. they may choose to limit their consumption and investment for precautionary purposes, as they foresee a possible further decline in prices and

5 The Holland (1995) argument is not applicable, as it refers to an inflationary environment where the monetary authority observes a damagingly high degree of inflation uncertainty and tries to contain it in order to curb inflation. In our case, the policy goal is to increase inflation in order to achieve the price stability objective.

economic activity. Such economic behaviour is one possible interpretation of the negative and statistically significant sensitivity coefficient during the past decade.

Our findings illustrate that the systematic effort made by the Eurosystem to anchor inflation expectations and limit inflation uncertainty is important for the trajectory of inflation itself and, during economic downturns and periods of deflation, it may help limit the likelihood of further deflation. In such circumstances, containing inflation uncertainty, i.e. enhancing the public's trust in the inflation-targeting monetary authority, is in itself a form of expansionary monetary policy. It follows that the extraordinary measures taken by the Eurosystem in order to maintain bank liquidity and the provision of credit to the private non-financial sector during the pandemic may also have operated by reducing inflation uncertainty, at a time when the deflationary effect of inflation uncertainty was at its highest in terms of both size and significance.

5 CONCLUSIONS

In this paper we provide time-varying estimates of economic uncertainty and inflation uncertainty for the Greek economy, and consider their impact on the corresponding macroeconomic variables, i.e. GDP growth and inflation. We find that, in both cases, the degree of uncertainty fluctuates over time. Moreover, its impact on the underlying variables also varies and has been significant during certain periods. *Inter alia* it seems to have been both significant and negative during the global financial crisis and the Greek sovereign debt crisis, as well as during the COVID-19 pandemic, weighing on the Greek economy's fundamentals. Our findings have a number of policy implications, not least that the extraordinary policy measures taken to contain the economic impact of the COVID-19 pandemic should be withdrawn gradually and with due caution, as any increase in uncertainty may have an adverse effect on economic activity and a deflationary impact on prices.

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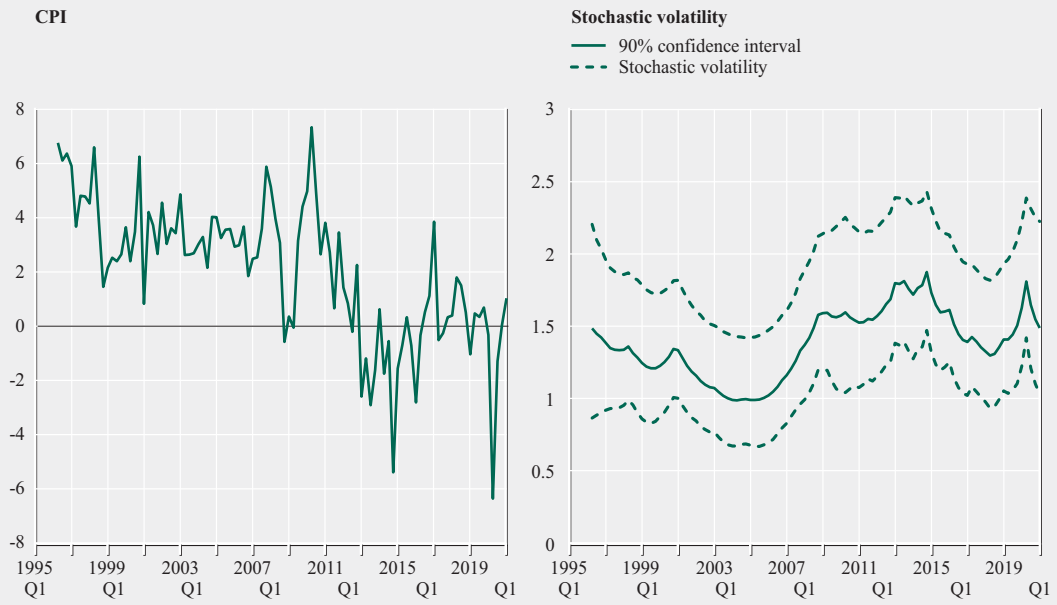
APPENDIX

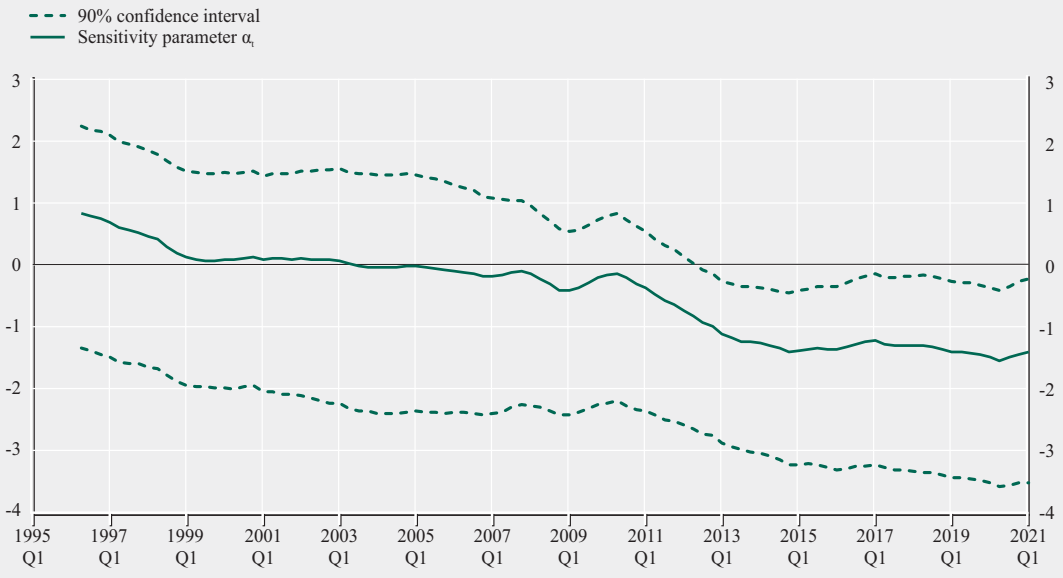
Chart A1 Inflation and inflation uncertainty (CPI) (1996Q2-2021Q1)

(%)



Sources: ELSTAT and Bank of Greece estimations.

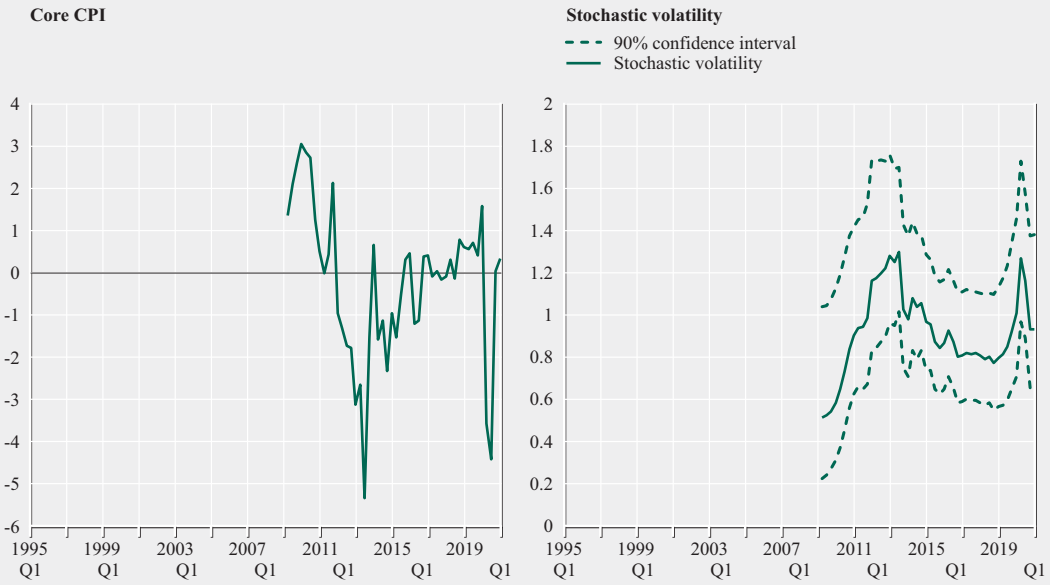
Chart A2 Time-varying coefficient, α_t, of inflation's sensitivity to changes in inflation uncertainty (CPI) (1996Q2-2021Q1)



Sources: Bank of Greece estimations.

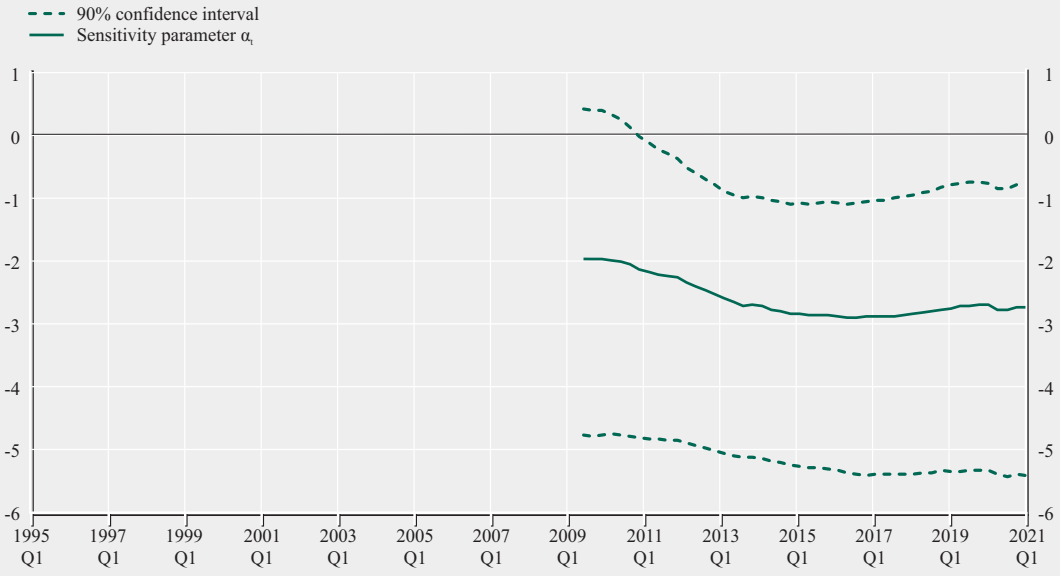
Chart A3 Inflation and inflation uncertainty (core CPI) (2009Q2-2021Q1)

(%)



Sources: ELSTAT and Bank of Greece estimations.

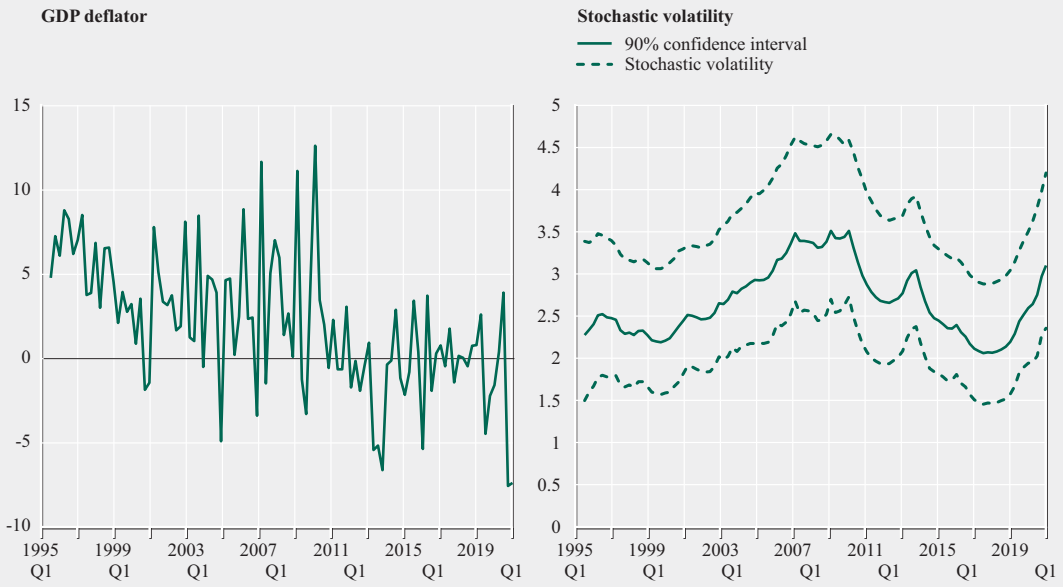
Chart A4 Time-varying coefficient, α_t, of inflation's sensitivity to changes in inflation uncertainty (core CPI) (2009Q2-2021Q1)



Sources: Bank of Greece estimations.

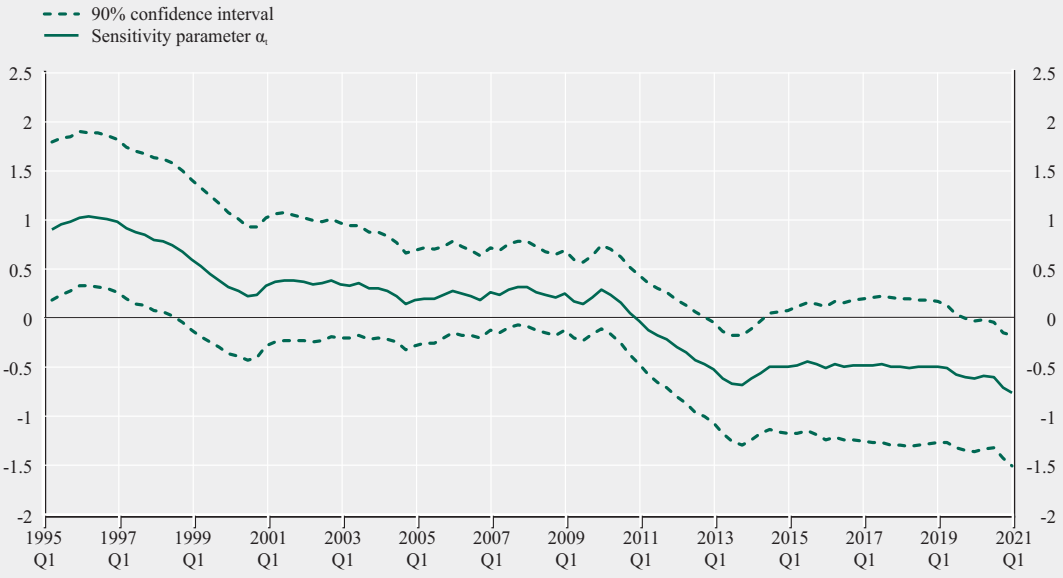
Chart A5 Inflation and inflation uncertainty (GDP deflator) (1995Q2-2021Q1)

(%)



Sources: ELSTAT and Bank of Greece estimations.

Chart A6 Time-varying coefficient, α_t, of inflation's sensitivity to changes in inflation uncertainty (GDP deflator) (1995Q2-2021Q1)



Sources: Bank of Greece estimations.