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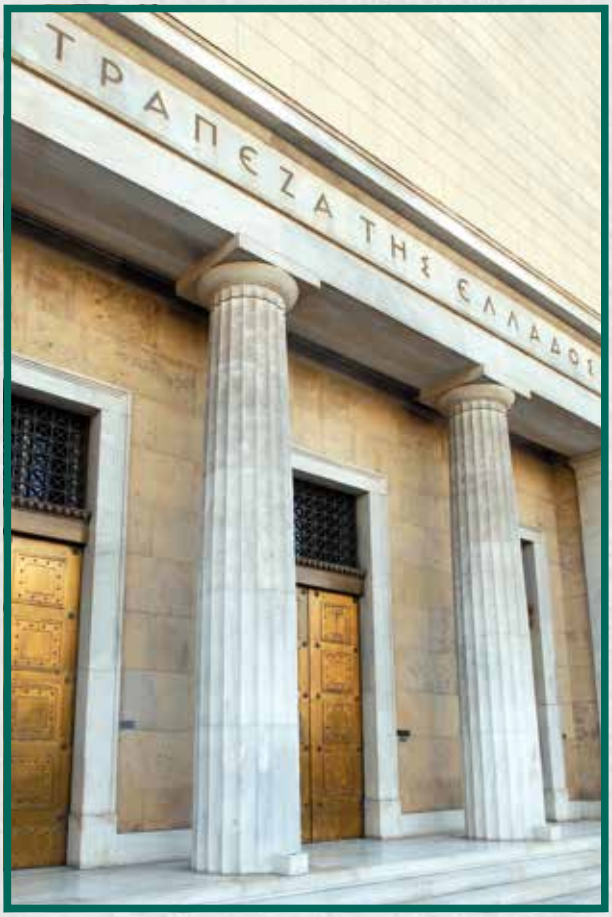

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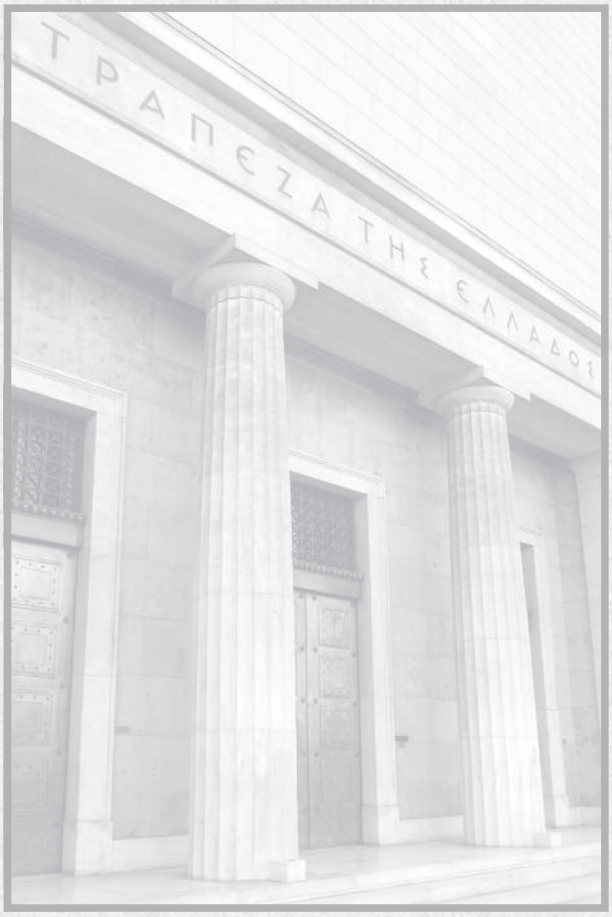

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ABSTRACT

This paper evaluates the effectiveness of Value Added Tax (VAT) reductions as a tool to mitigate inflation in Greece, combining empirical evidence with structural macroeconomic analysis. First, the estimation of a small-scale structural vector autoregression (SVAR) model reveals that temporary VAT reductions exert a statistically insignificant effect on inflation. Nevertheless, when VAT reductions are accompanied by enhancements in product market competition, the disinflationary effects become both significant and persistent. Second, the results from a Dynamic Stochastic General Equilibrium (DSGE) model calibrated to the Greek economy indicate that the short-run pass-through of VAT cuts to consumer prices is partial, ranging between 19% and 25% in the short term. This pass-through is highly influenced by structural factors and the persistence of policy interventions. Notably, permanent VAT cuts generate nearly twice the inflation pass-through compared to temporary ones. The disinflationary impact is also stronger in economies with more competitive product markets, where firms are more likely to transmit cost reductions to prices. Conversely, in economies characterised by relatively high nominal rigidities or limited domestic input use, the inflation response to VAT reductions is diminished. Overall, the results of the study demonstrate the significance of structural conditions in determining the inflationary outcomes of VAT-based fiscal measures.

Keywords: VAT reduction; inflation; fiscal policy; tax rate pass-through; SVAR; DSGE; Greece

JEL classification: C32; E31; E62; H20; O52

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ΜΕΤΑΒΟΛΕΣ ΤΟΥ ΦΠΑ ΚΑΙ ΠΛΗΘΩΡΙΣΜΟΣ: ΜΙΑ ΕΜΠΕΙΡΙΚΗ ΚΑΙ ΘΕΩΡΗΤΙΚΗ ΑΝΑΛΥΣΗ ΓΙΑ ΤΗΝ ΕΛΛΗΝΙΚΗ ΟΙΚΟΝΟΜΙΑ

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ΠΕΡΙΛΗΨΗ

Η παρούσα μελέτη διερευνά την αποτελεσματικότητα των μειώσεων του Φόρου Προστιθέμενης Αξίας (ΦΠΑ) ως εργαλείου περιορισμού του πληθωρισμού στην ελληνική οικονομία, συνδυάζοντας την εμπειρική τεκμηρίωση με τη διαρθρωτική μακροοικονομική ανάλυση. Τα αποτελέσματα που προκύπτουν από τη χρήση ενός μικρής κλίμακας διαρθρωτικού αυτοπαλίνδρομου διανυσματικού υποδείγματος (SVAR) υποδηλώνουν ότι οι προσωρινές μειώσεις του ΦΠΑ έχουν στατιστικά μη σημαντική επίδραση στον πληθωρισμό. Ωστόσο, όταν οι μειώσεις του ΦΠΑ συνοδεύονται από πολιτικές που ενισχύουν τον ανταγωνισμό στην αγορά προϊόντων, οι αποπληθωριστικές επιδράσεις καθίστανται σημαντικές και διατηρήσιμες. Παράλληλα, τα αποτελέσματα από ένα δυναμικό στοχαστικό υπόδειγμα γενικής ισορροπίας (DSGE), το οποίο διαμετρείται για την ελληνική οικονομία, δείχνουν ότι η μετακύλιση των μειώσεων του ΦΠΑ στις τιμές καταναλωτή βραχυπρόθεσμα είναι μερική και εκτιμάται μεταξύ 19% και 25%. Ο βαθμός μετακύλισης επηρεάζεται από διαρθρωτικούς παράγοντες, καθώς και από τη διάρκεια της εφαρμογής του μέτρου. Οι μόνιμες μειώσεις του ΦΠΑ σχεδόν διπλασιάζουν τη μετακύλιση στις τιμές σε σύγκριση με τις προσωρινές. Οι αποπληθωριστικές επιδράσεις είναι επίσης ισχυρότερες σε οικονομίες με πιο ανταγωνιστικές αγορές, όπου οι επιχειρήσεις είναι πιο πρόθυμες να μετακυλίσουν τις μειώσεις κόστους στις τιμές. Αντιθέτως, σε οικονομίες που χαρακτηρίζονται από υψηλό βαθμό δυσκαμψιών ή περιορισμένη χρήση εγχώριων εισροών, οι επιδράσεις στον πληθωρισμό από μειώσεις του ΦΠΑ είναι ασθενέστερες. Συνολικά, τα ευρήματα της μελέτης αναδεικνύουν το ρόλο των διαρθρωτικών και θεσμικών χαρακτηριστικών στον τρόπο με τον οποίο οι μεταβολές του ΦΠΑ επηρεάζουν τον πληθωρισμό.

ΜΗ ΤΕΧΝΙΚΗ ΣΥΝΟΨΗ

Η πρόταση για προσωρινή και στοχευμένη μείωση του συντελεστή Φόρου Προστιθέμενης Αξίας (ΦΠΑ) σε ορισμένες κατηγορίες βασικών αγαθών, όπως τρόφιμα και ενέργεια, επανήλθε στο προσκήνιο τα τελευταία χρόνια ως μέτρο πολιτικής έναντι του κύματος πληθωριστικών πιέσεων και υιοθετήθηκε από αρκετές χώρες της ευρωζώνης. Οι πιέσεις αυτές απορρέουν κυρίως από την αύξηση του κόστους της ενέργειας και των πρώτων υλών, καθώς και από διαταράξεις στην εφοδιαστική αλυσίδα, κυρίως λόγω του πολέμου στην Ουκρανία. Όπως προκύπτει από τη σχετική βιβλιογραφία, η αποτελεσματικότητα μιας μείωσης του ΦΠΑ στον περιορισμό του πληθωρισμού παραμένει αντικείμενο συζήτησης, καθώς εξαρτάται κυρίως από τα διαρθρωτικά και θεσμικά χαρακτηριστικά των οικονομιών, όπως είναι για παράδειγμα ο βαθμός ανταγωνισμού στις αγορές προϊόντος και εργασίας, καθώς και τις στρατηγικές τιμολόγησης των επιχειρήσεων.

Με βάση τα παραπάνω, η παρούσα μελέτη εξετάζει τις επιδράσεις μιας προσωρινής μείωσης του ΦΠΑ στον πληθωρισμό στην Ελλάδα, τόσο από θεωρητική όσο και από εμπειρική σκοπιά, ακολουθώντας την εξής μεθοδολογική προσέγγιση. Αρχικά, χρησιμοποιείται ένα διαρθρωτικό αυτοπαλίνδρομο διανυσματικό υπόδειγμα (SVAR) με στόχο να διερευνηθούν οι επιδράσεις μιας μείωσης του ΦΠΑ στον πληθωρισμό, καθώς και ο ρόλος βασικών διαθρωτικών παραγόντων, όπως ο βαθμός ανταγωνισμού στην αγορά προϊόντος, στη μετακύλιση της μείωσης του ΦΠΑ στις τιμές. Στη συνέχεια, χρησιμοποιείται ένα δυναμικό στοχαστικό υπόδειγμα γενικής ισορροπίας (DSGE model), το οποίο διαμετρείται για την ελληνική οικονομία, προκειμένου να εξεταστούν οι μακροοικονομικές επιδράσεις από μια μείωση του ΦΠΑ. Η ανάλυση εστιάζει στη μετακύλιση της εν λόγω μείωσης στις τιμές καταναλωτή και στο ρόλο των διαρθρωτικών και θεσμικών χαρακτηριστικών, όπως ο βαθμός ανταγωνισμού στην αγορά προϊόντος και οι δυσκαμψίες στις τιμές και τους μισθούς, στη διαμόρφωση των διαύλων μετάδοσης της εν λόγω φορολογικής παρέμβασης στην οικονομική δραστηριότητα.

Τα αποτελέσματα της μελέτης δείχνουν ότι η αποτελεσματικότητα μιας μεμονωμένης μείωσης του ΦΠΑ ως μέτρου περιορισμού του πληθωρισμού στην ελληνική οικονομία είναι περιορισμένη βραχυπρόθεσμα, καθώς η μετακύλισή της στις τελικές τιμές καταναλωτή είναι μόνο μερική. Αντιθέτως, διαπιστώνεται σημαντική και διατηρήσιμη αποκλιμάκωση του πληθωρισμού όταν η μείωση του ΦΠΑ συνοδεύεται από διαρθρωτικά μέτρα που ενισχύουν τον ανταγωνισμό στις αγορές προϊόντων και υπηρεσιών.

Παράλληλα, τα αποτελέσματα της ανάλυσης υποδηλώνουν ότι η επίδραση της μείωσης του ΦΠΑ στις τιμές εξαρτάται σε μεγάλο βαθμό από τη διάρκεια της εφαρμογής του μέτρου. Οι μόνιμες μειώσεις ΦΠΑ είναι πιο αποτελεσματικές από τις προσωρινές, καθώς ενισχύουν την αξιοπιστία της οικονομικής πολιτικής και επηρεάζουν θετικά τις προσδοκίες των νοικοκυριών και των επιχειρήσεων. Εκτιμάται ότι μια μόνιμη μείωση του ΦΠΑ σχεδόν διπλασιάζει τη μετακύλιση στις τιμές σε σύγκριση με μια προσωρινή μείωση. Αντιθέτως, σε οικονομίες με υψηλό βαθμό δυσκαμψιών στις τιμές και τους μισθούς ή με περιορισμένη χρήση εγχώριων εισροών στην παραγωγική διαδικασία, η αποτελεσματικότητα της μείωσης του ΦΠΑ στον περιορισμό των πληθωριστικών πιέσεων είναι ασθενέστερη.

Το γενικό συμπέρασμα της μελέτης είναι ότι η μείωση του ΦΠΑ, από μόνη της, δεν επαρκεί ως εργαλείο για την αποκλιμάκωση των πληθωριστικών πιέσεων στην ελληνική οικονομία, καθώς η αποτελεσματικότητά της εξαρτάται σε μεγάλο βαθμό από το ευρύτερο θεσμικό και διαρθρωτικό περιβάλλον. Η αξιοποίηση του ΦΠΑ ως αποτελεσματικού μέσου αποπληθωριστικής παρέμβασης προϋποθέτει την ένταξή του σε ένα ευρύτερο πλαίσιο οικονομικής πολιτικής, το οποίο περιλαμβάνει συμπληρωματικές διαρθρωτικές παρεμβάσεις. Οι παρεμβάσεις αυτές θα

πρέπει να στοχεύουν στην ενίσχυση του ανταγωνισμού στις αγορές προϊόντων και υπηρεσιών και στη μείωση των στρεβλώσεων στην οικονομία, προκειμένου να ενισχυθεί η μετακύλιση των μέτρων φορολογικής πολιτικής στις τιμές καταναλωτή.

VAT RATE SHOCKS AND INFLATION: A THEORETICAL AND EMPIRICAL ANALYSIS FOR GREECE*

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I INTRODUCTION

The proposal for a temporary and targeted reduction of the Value Added Tax (VAT) rate on certain categories of goods (such as basic foodstuffs and energy) has recently come to the fore in response to a surge in inflation, which, in turn, is the result of rising energy and commodity prices, as well as supply bottlenecks mainly due to the Russo-Ukrainian war.

In the European Union, Spain was the first country to adopt temporary VAT rate cuts on basic foodstuffs[1] and energy[2] as part of a strategy to contain recent inflationary pressures (after the end of 2021). The initial plan was for these temporary tax rate reductions to expire by the end of 2023, with the possibility of extension depending on inflation trends and broader economic conditions. After this, similar policy measures were adopted by other euro area economies, including Germany, France, Belgium, Italy and Portugal, with regard to both basic goods and energy. In the case of Greece, since the end of the pandemic, the authorities have implemented targeted interventions to address increased energy prices. However, they have largely maintained VAT rates at the elevated levels introduced during the economic adjustment period, in order to achieve the necessary fiscal adjustment.[3]

As demonstrated by the relevant empirical literature, the effectiveness of a VAT reduction in containing inflation remains a subject of debate, as it is contingent on several factors. According to Blundell (2009), who analyses the 2009 temporary VAT rate cuts in the UK, the impact on inflation is limited, as these tax cuts boost real income and demand, which, in turn, fuel inflation. At the same time, several studies assess the impact of VAT cuts on a more disaggregated level, that is, on specific goods and services markets.[4] These studies indicate that the pass-through of VAT rate cuts to retail prices varies significantly across different markets and is influenced by market structure (e.g. firm size), the degree of competition, pricing strategies, the penetration of e-commerce and e-shopping in households' purchases and the extent of product diversification.[5] These findings emphasise the broader view that the effectiveness of VAT cuts in reducing inflation is not uniform across economies or sectors, but rather contingent on deeper structural and institutional features. In this context, the transmission of exogenous shocks —including fiscal measures such as VAT cuts— to inflation is heavily influenced by country-specific structural and institutional characteristics. These include, for example, the

* The views expressed in this article are of the authors and do not necessarily reflect those of the Bank of Greece. The authors are responsible for any errors or omissions.

1 VAT was cut from 4% to 0% for certain products such as bread, milk, cheese, fruit, vegetables and cereals and from 10% to 5% for meat and fish.

2 For example, VAT on electricity was reduced from 21% to 5% to mitigate the impact of high energy prices on households and businesses.

3 It should be noted that, during the pandemic, Greece introduced several income support measures and benefits, as well as temporary tax exemptions, which aimed to sustain consumers' purchasing power. In this context, Greece reduced VAT on electricity and natural gas from 13% to 6%, and on the catering sector from 24% to 13% (for a detailed description of relevant fiscal measures, see previous Bank of Greece Annual Reports, Section "Institutional framework and fiscal reforms"). The country's limited interventions in the period following the outbreak of the Russo-Ukrainian war included VAT rate cuts for inputs used in livestock production and agriculture (feed, fertilisers, etc.), and an extension of the exemptions in force (in the form of a reduced VAT rate) for specific sectors (such as non-alcoholic beverages, transport and gyms, real estate).

4 Depending on the data format and the structure of the markets under examination, alternative empirical methods of analysis mainly involve the use of structural vector autoregression, as well as the use of panel data models. Markets where the effects of VAT rate cuts have been studied, include: (i) hairdressing (Kosonen 2015), (ii) film (Moral and Gómez-Antonio 2020), (iii) catering (Harju and Kosonen 2014), and (iv) food and beverages (Benzarti et al. 2024; De Amores Hernandes et al. 2023 and Fuest et al. 2025). In addition, artificial intelligence technologies are lately being used to exploit electronic transaction data in real time (see Forteza et al. 2024).

5 For example, see Hindriks and Serse (2019) as well as Copestake and Bellon (2022).

degree of product market competition, labour market rigidities, firms' pricing behaviour and the interplay between policy persistence and private sector expectations.[6]

To illustrate this point, consider a temporary reduction in the VAT rate. The immediate effect on inflation is a decline in the price level, as the lower tax rate directly reduces consumer prices. Nevertheless, this initial disinflationary impact may be partially offset by subsequent demand-side dynamics. Specifically, the implementation of this measure produces a positive income effect, thereby strengthening households' purchasing power and stimulating consumption. Furthermore, given the temporary nature of the tax reduction, consumers may choose to postpone future consumption in favour of the present, thereby generating an intertemporal substitution effect that would serve to further boost short-run demand and inflationary pressures.

From a supply-side perspective, the impact of a reduction in VAT is determined by its interplay with firms' marginal costs. Under perfect competition, broad-based VAT rate cuts —including those affecting the cost of production inputs— are expected to reduce production costs, enhance firms' productive capacity and eventually lead to higher output and lower prices. In contrast, under imperfect competition[7] (e.g. oligopolistic or monopolistic market structures), a decline in production costs, along with a reduction in consumer prices (due to a decrease in the VAT rate), has the potential to result in elevated profit margins for firms, with minimal consequences for production. In such environments, the pass-through of VAT rate cuts to retail prices may be incomplete and inflation may prove more persistent, thereby reducing the effectiveness of this policy measure. Ultimately, the net effect on inflation is contingent upon the interaction between pricing behaviour, market structure and the strength of demand and supply-side responses.

In this context, the objective of the present paper is to investigate the implications of a reduction in VAT rates on inflation in Greece, from both a theoretical and an empirical perspective. In order to address this issue, the following approach is adopted. First, a small-scale structural vector autoregression (SVAR) model is employed to analyse the key factors influencing the pass-through of a VAT reduction to inflation. These factors include the degree of product market competition and monetary policy reactions, and the evaluation of their role in shaping observed inflation dynamics. Second, a Dynamic Stochastic General Equilibrium (DSGE) model calibrated to the Greek economy is used to examine the macroeconomic effects of consumption tax rate cuts. The analysis focuses on the pass-through to consumer prices and the role of structural and policy-related factors —such as market competition, price and wage rigidities, and policy persistence— in shaping the transmission mechanism.

The paper relates and contributes to two strands of literature. The first is the empirical examination of the effectiveness of VAT reductions in containing inflation. While existing research in this area predominantly relies on disaggregated data to estimate the impact of VAT changes on prices, this paper makes a novel contribution by providing macro-level estimates using a SVAR approach. The second strand relates to the general equilibrium effects of VAT changes. To the best of our knowledge, there is limited evidence regarding the quantification of the pass-through of VAT cuts to inflation within a general equilibrium setting, accounting for the structural and policy determinants.[8] Our paper bridges these two strands. It offers a unified framework to assess the broader macroeconomic implications of

6 See Galí and Gertler (1999), Blanchard and Giavazzi (2003), Fabiani et al. (2006), Christiano et al. (2005), as well as Blanchard and Galí (2007) and the references in footnote 5.

7 Under conditions of monopolistic competition, undertakings determine the level of production and —given the aggregate demand— the price, whereas under oligopolistic competition, they determine the production level, while prices are linked to the strategies of the other firms in the oligopoly sector.

8 See Voigts (2016), who finds that the VAT pass-through to inflation depends on the modelling specification of consumption and VAT taxes. There are several studies that examine the impact of consumption taxes on output using a similar framework (see, e.g. Forni et al. 2009 and Coenen et al. 2008).

VAT reductions. Finally, our paper contributes to the body of literature that empirically examines the pass-through of VAT changes in the Greek economy.[9]

The results of the empirical analysis reveal that the direct impact of a VAT cut on inflation is limited and statistically insignificant at the macro level. This suggests that this measure is not very effective in the short term. By contrast, a significant and sustained fall in inflation is observed in response to increased market competitiveness, as reflected by a reduction in aggregate markups. This indicates that enhanced market competition strengthens the pass-through of VAT reductions to consumer prices. Robustness checks using local projections confirm these findings, showing that improvements in market competition result in long-term reductions in inflation. Further confirmation comes from a scenario analysis, which shows that the effectiveness of VAT cuts in reducing inflation depends critically on the degree of competition in goods and services markets. VAT cuts only result in meaningful disinflation when accompanied by structural reforms that reduce markups, highlighting the interplay between fiscal policy and market structure.

Moreover, the results from the DSGE model suggest that a temporary consumption tax rate cut reduces inflation and boosts output in the short term. However, the pass-through to inflation is only partial, with estimates ranging between 19% and 25% in the first year following implementation, figures that lie at the lower end of the empirical estimates. The analysis further reveals that structural and policy-related factors critically influence the magnitude of the inflation response. Notably, a permanent tax cut nearly doubles the short-term pass-through, underscoring the importance of policy credibility and expectations in the design of fiscal interventions. The inflationary impact of the tax cut is also found to be stronger in more competitive economies, consistent with the findings from the empirical analysis. Moreover, the disinflationary effect of the tax cut is more muted in economies where firms adjust prices infrequently, as nominal rigidities delay the transmission of cost changes to consumer prices. The pass-through is larger in economies with more flexible labour markets, where wages adjust more rapidly to shocks, thereby amplifying the impact on marginal costs and prices. Finally, the disinflationary impact is more pronounced in economies with stronger home bias in input sourcing, highlighting the importance of production structure and supply-chain configuration in shaping fiscal transmission.

The rest of the paper is organised as follows: Section 2 presents the empirical model and the main empirical estimates. Section 3 describes the theoretical model and presents the main results from the simulations, while Section 4 concludes.

2 EMPIRICAL MODEL

We employ standard empirical analysis in the area as adopted by numerous articles (Afonso et al. 2009; Caldara and Kamps 2008; Alesina et al. 2012) that assess the implications of fiscal shocks on aggregate inflation. Our analysis uses a simplified VAR model based on quarterly Greek data from 2000q1 to 2024q1. The chosen period covers key milestones affecting the domestic economy: Greece's entry into the EMU in 2001, the sovereign debt crisis in 2010 and the subsequent economic crisis, the pandemic and, to a lesser extent, the impact of the war in Ukraine.

The general specification is as follows:

$$Y_t = A_0 + \sum_{i=1}^{p} A_i Y_{t-i} + \sum_{j=1}^{q} B_j X_{t-j} + e_t \quad (1)$$

where Y_t denotes the vector of endogenous variables and X_t denotes the vector of exogenous variables of our VAR model for the Greek economy, while p and q denote lag structure (up to 4 lags utilised).

In our analysis, we keep a small number of endogenous quarterly variables $Y_t=(\pi_t, y_t, mu_t)$,

9 See Dimitrakopoulou et al. (2024).

where π_t denotes the annualised inflation (y-o-y) derived from the HICP index[10] and y_t is the annualised real GDP growth rate of the Greek economy (y-o-y) and mu_t the total economy's markup constructed as in Papageorgiou and Rizos (2024).[11] In our set of exogenous variables, we have included variables of interest denoted with the vector $X_t=(r_t, \tau_t)$, where r_t denotes the quarterly average of the 3-month Euribor and, with a view to portraying fiscal shocks, τ_t denotes the applied statutory VAT rate extrapolated to a quarterly frequency (incorporated up to 4 lags).[12]

In the light of the Ordinary Least Squares (OLS) Vector Autoregressive (VAR) model, this study undertakes an evaluation of the repercussions of a VAT rate reduction and its subsequent transmission to inflation within the Greek economy. To this end, a simplified Cholesky decomposition is employed, under the assumption of a sequence of shocks initiated by the VAT rate reduction in question and propagating to markup, growth and inflation. The impulse responses of inflation and output to a VAT statutory tax rate and markup shock are presented in the panels of Chart 1.

As demonstrated in the left-hand side panels of Chart 1, the impact of a VAT rate reduction is projected[13] to reduce the overall inflation rate. However, these projections appear to be statistically insignificant at 95% significance level.[14] A similar response is exhibited in the case of real output growth to a VAT cut shock.[15] In the case of a negative markup shock (right-hand side panels of Chart 1), an improvement in competition (as expressed by the decline in markup by 1 standard deviation) has a negative and statistically significant effect on inflation in the medium run, i.e. after 5-6 quarters. The estimated adverse effect on output is also found to be insignificant at the 95% level of significance.[16]

As a robustness test, the local projection variant of impulse responses (Jordà 2005) is employed, following the same model specification (see Chart A1 of the Appendix).[17] The estimated effects of changes to statutory VAT rates on inflation are found to be negligible and these effects are observed to dissipate rapidly, thereby verifying that the impact of a VAT cut on inflation is at best limited in the case of the Greek economy. A similar VAT cut is also shown to have a muted effect on output. Conversely, a reduction in markup, indicative of enhanced competition, has been found to produce statistically significant disinflationary effects at the 95% confidence level after a period of six to seven quarters. This finding signifies that enhancing competition results in a decline in inflation in the medium term (see Chart A1 of the Appendix). However, the responses of output to enhanced competition have not been determined to be statistically significant.

2.1 CONDITIONS UNDER WHICH A VAT RATE SHOCK COULD BE TRANSMITTED TO INFLATION: THE ROLE OF MARKET COMPETITION

A small number of additional scenarios are simulated on the basis of the estimated VAR model to provide a more precise understanding of the factors that can lead to an improvement in the effectiveness of VAT reductions in terms

10 Quarterly data on y-o-y inflation is defined as $\pi_t = \frac{a_t - a_{t-4}}{a_{t-4}}$, where a_t is the 3-month average of the HICP index published by ELSTAT. This approximation is very close to the 12-month annualised inflation rate published monthly by the Hellenic Statistical Authority (ELSTAT).

11 A rough proxy for quarterly price markups for the total economy has been constructed using non-financial transactions data from Eurostat. Markups are defined as the ratio of the net operating surplus and mixed income to total input costs. Total input costs are proxied as the sum of intermediate consumption and consumption of fixed capital.

12 Our estimation is based on a limited number of restrictions imposed on the elements of matrix coefficient B_j, as denoted in the Appendix (Table A1).

13 Assuming symmetry of response between a positive and a negative shock. Similar analysis at the 90% leads to similar conclusions findings.

14 There have been similar findings, when, instead of the statutory VAT rate, we used a proxy of the implied VAT rate, defined as the VAT revenues divided by private consumption adjusted for the VAR revenues and seasonally adjusted (STL seasonal adjustment).

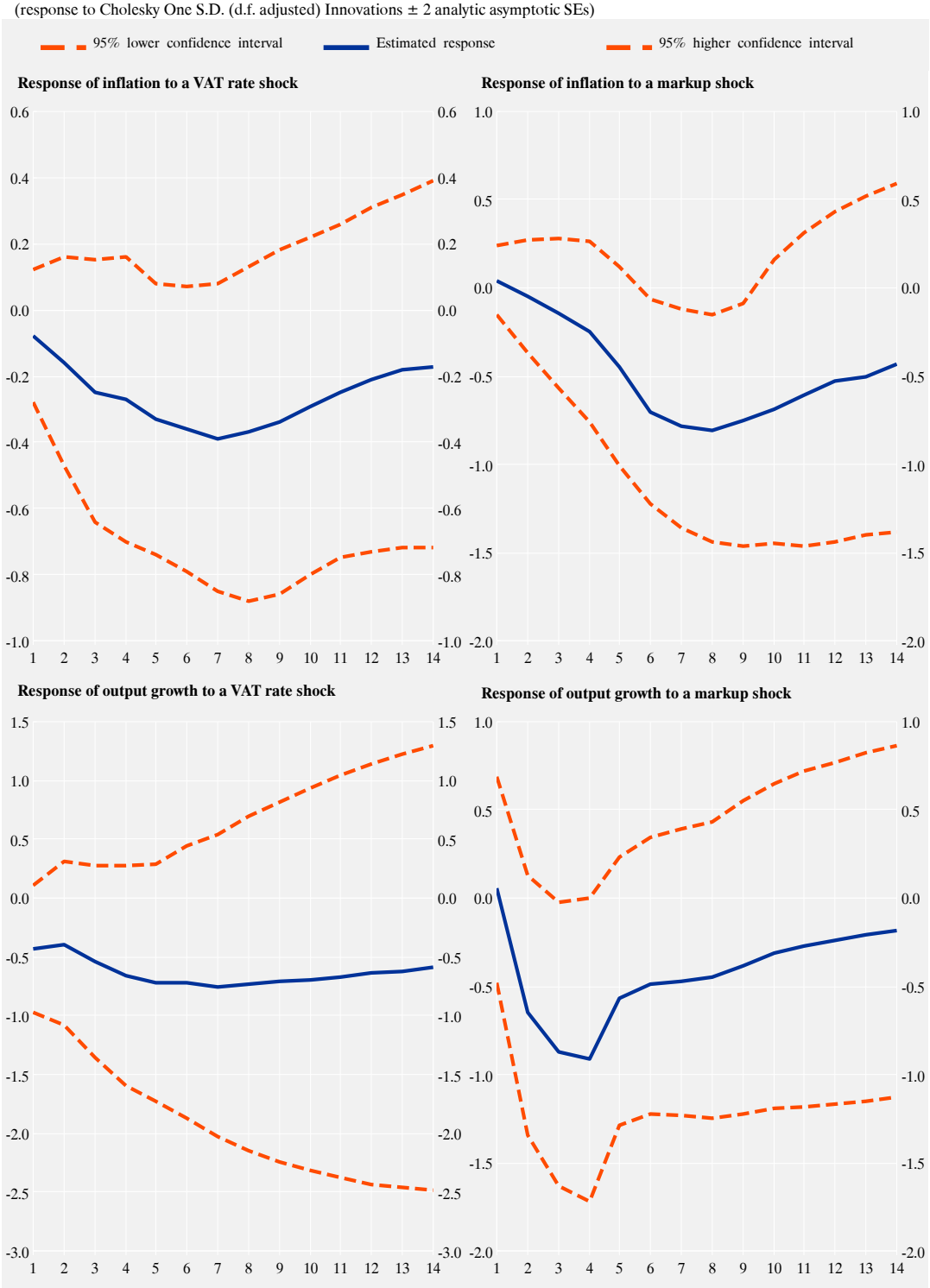
15 According to Kneller et al. (1999), as well as Rapanos and Kaplanoglou (2014), the change in VAT rates does not by itself affect the factors of the production function through substitution effects and does not affect saving and investment decisions or businesses' competitiveness through exports.

16 It should also be noted that, given the aggregate level of data, the observed impact on output is the result of multiple factors, e.g. type of competition, product market differentiation, size of markets, barriers to entry and exit, linkages with external environment, etc.

17 Assuming symmetry of response between a positive and a negative shock.

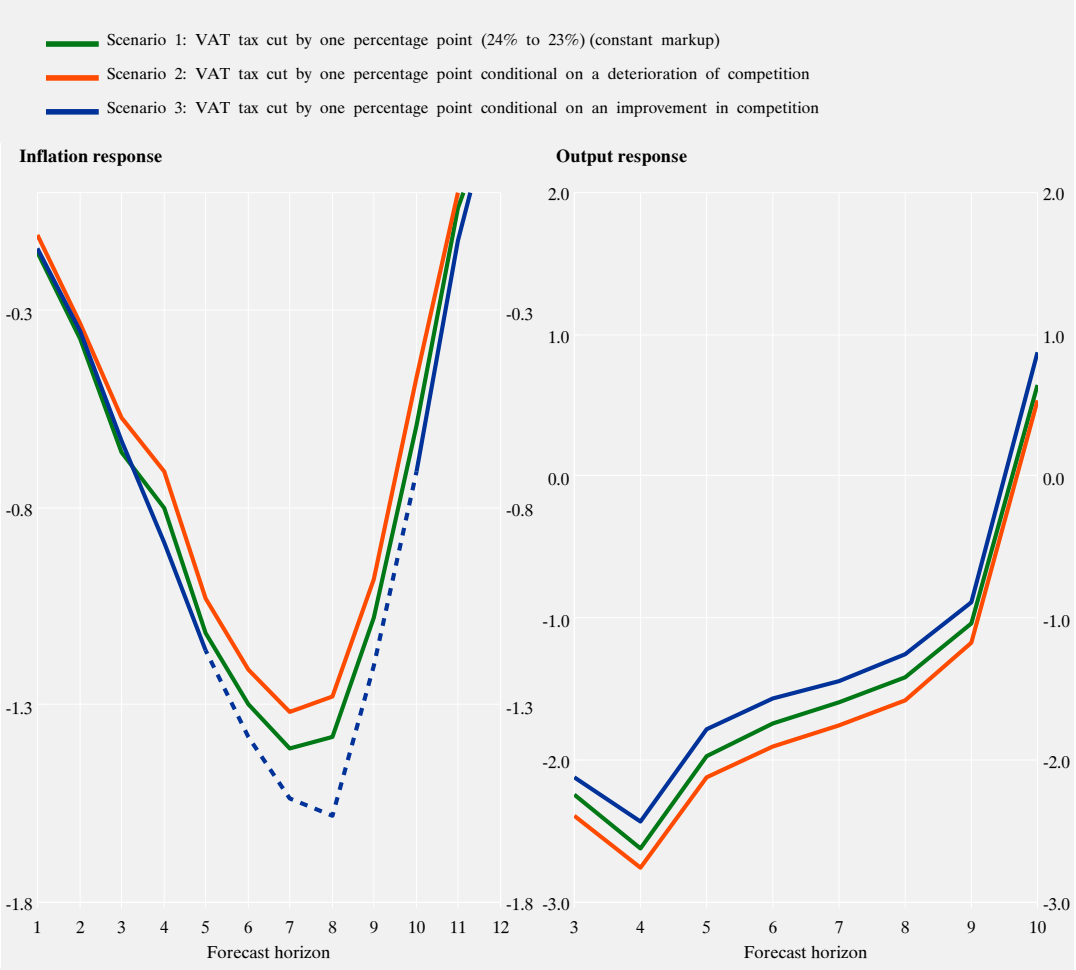
Chart 1 Impulse response functions of inflation and growth to a negative shock to the statutory VAT rate and to markup (improvement in competition)

(response to Cholesky One S.D. (d.f. adjusted) Innovations ± 2 analytic asymptotic SEs)



Source: Authors' estimations and Bank of Greece.

Chart 2 Scenario analysis: estimated inflation and output response based on the VAR model (eq. 1) under Scenarios 1, 2 and 3 (see note below for details)



Sources: Authors' estimations and Bank of Greece. The dashed lines denote statistical significance at 95%.
Note: Scenario 1 portrays a decline in inflation (pass-through) resulting from a temporary reduction by one percentage point in the VAT statutory rate. Scenario 2 is defined as Scenario 1 plus a trend increase in markup (i.e. less competition in products and services) to historic highs and Scenario 3 is defined as Scenario 1 plus a trend decline in markup to historic lows after the Greek crisis (more competition in products and services).

of their pass-through to inflation. A reduction in the VAT rate as a measure to combat high inflation is also influenced by the structural characteristics and functioning of goods and services markets. It is evident that an increase in competition, coupled with the removal of structural impediments to competition, tends to facilitate the transmission of VAT rate reductions to inflation, thereby increasing their impact. In the event of an increase in structural impediments (leading to an increase in markups), which constitutes a deterioration in competitive conditions, fiscal interventions through VAT are more likely to be reversed and short-lived.

We portray the role of imperfect competition in the pass-through of VAT rate changes to inflation using three scenarios (see Chart A2 of the Appendix). In the first scenario, the markup remains constant at the level observed in 2024q1, while the statutory VAT rate is temporarily reduced by one percentage point from 24% to 23% as of 2024q3, returning to 24% by

2026q1. In the second scenario, a similar fiscal shock is assumed, accompanied by a gradual increase in the markup, with the aim of reaching the high markup levels observed in the Greek economy immediately after the adoption of the euro (see Scenario 2 in Chart A2 of the Appendix).

In the third scenario, a similar fiscal policy shock is postulated together with a linear decline in the markup, with the aim of achieving the reduced markup levels that were observed during the Greek sovereign crisis, when the markup reached unprecedented lows in 2018 (see Scenario 3 in Chart A2 of the Appendix). The simulated estimates of all three scenarios express deviations from a common baseline scenario, where all variables remain constant to the last observation (ceteris paribus).

As shown in Chart 2, the improvement in competition and the removal of structural impediments to greater competition, as assumed in Scenario 3, are estimated to improve the pass-through of VAT reductions to inflation and prolong their impact, as the estimated effect becomes statistically significant for a number of quarters after the assumed reduction in the VAT rate to 23%. In the event of an increase in structural impediments (i.e. markups) leading to a deterioration in competition, the impact of fiscal policy interventions through VAT reductions on inflation is estimated to be muted, as the assumed reduction in VAT rates does not have a statistically significant impact on inflation (at the 95% significance level). Finally, as regards the response of output, Chart 3 shows that there is no discernible difference between the three scenarios in terms of output, as the response of output is not statistically significant throughout the assumed forecast horizon.

3 CONSUMPTION TAX RATE PASS-THROUGH: A GENERAL EQUILIBRIUM APPROACH

In this section we employ a DSGE model to analyse the macroeconomic effects of a reduction in the consumption tax rate, with a particular focus on its effectiveness in curbing inflationary pressures. The analysis proceeds in three main steps.

First, we examine the dynamic responses of a temporary cut in the consumption tax rate to explore the transmission mechanisms and identify the main propagation channels through which the shock affects key macroeconomic variables. Second, we quantify the pass-through of the consumption tax rate cut to price inflation, measuring the extent to which the reduction in the tax rate translates into lower prices. This measure provides a benchmark for assessing the short-term effectiveness of the policy in mitigating inflation. Third, we explore, through comparative simulations, a set of structural and policy-related factors that may influence the pass-through magnitude to identify the conditions under which consumption tax reductions are more or less likely to generate substantial disinflationary effects.

3.1 DESCRIPTION OF THE THEORETICAL MODEL

The model employed is a version of the Bank of Greece micro-founded Dynamic Stochastic General Equilibrium (DSGE) model that shares the standard main characteristics of structural models used by most central banks and international institutions.[18]

In particular, the domestic economy is modelled as a standard small open economy that belongs to a currency area in the sense that the nominal exchange rate is exogenous and there is no monetary policy independence. In the absence of autonomous monetary policy, the domestic nominal interest rate is determined by an exogenously given, risk-free, foreign nominal policy interest rate and a risk-premium component. The domestic economy consists of a large number of households, firms and a government. There are two types of households differing in their ability to partic-

18 For details on the main features of the model, see Papageorgiou and Vourvachaki (2017) and Papageorgiou (2014).

ipate in asset markets. The first type of households has access to the financial markets and can transfer wealth intertemporally by trading bonds and accumulating physical capital, whereas the second type of households is assumed to be liquidity-constrained in the sense that it cannot lend or borrow. Both types of households receive labour income by working in the private and the public sector.

The model incorporates a number of real and nominal frictions, such as price and wage rigidities and monopoly distortions in product and labour markets. As regards the labour market in the private sector, households supply differentiated labour services and there are labour unions that act as wage setters in monopolistically competitive labour markets. As a result, private sector real wages can deviate from the marginal product of labour and respond sluggishly to economic conditions, due to the existence of frictions and imperfections in the labour market. In particular, the real wage rate per hour, w_t, is a weighted average of the past wage rate and the optimal wage rate chosen by unions: $w_t=(w_{t-1})^n (w_t^*)^{1-n}$, where $0 \leq n \leq 1$ denotes the degree of real wage rigidity and w_t^* is the optimal wage rate chosen by unions that is equal to a markup over the marginal product of labour. The higher the value of parameter n, the higher the degree of wage rigidity.[19]

As regards the production sector, the model features monopolistically competitive firms that produce tradable and non-tradable differentiated intermediate goods. Firms in the tradable sector sell their output domestically and in the rest of world (recorded as exports), while firms in the non-tradable sector sell their output only domestically. There are also importing firms that import intermediate goods from abroad and operate under monopolistic competition. Once differentiated, the imported intermediate goods are then supplied as inputs into the production of final goods. Firms set the prices of their differentiated output according to the Calvo-type scheme with partial indexation. All types of intermediate goods are used as inputs to produce consumption and investment final goods. The latter are produced by perfectly competitive firms and are sold to domestic households and the government.

The model also includes a relatively detailed fiscal policy block. In particular, the government hires labour and combines public consumption and public employment to produce public goods that provide direct utility to households. It levies taxes on consumption and on income from labour and capital earnings, as well as lump-sum taxes, and issues one-period government bonds in the domestic bond market and the international markets. Total tax revenues plus the issue of new government bonds are used to finance public purchases of goods and services, public investment, government transfers and public sector wages. Public investment is used for the accumulation of public capital that creates production externalities to the private sector, thereby affecting the productivity of the private sector's factors of production, namely capital and labour. The model also features sovereign risk premia that are positively correlated with government indebtedness, thereby introducing a sovereign risk channel through which sovereign default risk is transmitted to the real economy.

Finally, the model includes a number of nominal and real frictions such as habit formation in consumption, investment adjustment costs and variable capital utilisation, which have been empirically identified as playing an important role in the transmission of structural shocks. Overall, the model captures well the key features of a typical small open economy of the Eurozone and, thus, provides a parameterised general equilibrium model suitable for policy simulations.

3.2 METHODOLOGY AND POLICY EXPERIMENTS

The approach to assess the effects of reductions in the consumption tax rate is sum-

19 For more details, see also Hall (2005), Blanchard and Galí (2007) and Papageorgiou (2014).

marised as follows: First, the model is calibrated at a quarterly frequency, meaning that specific values are assigned to the structural parameters and exogenous policy instruments to reflect the key features of the Greek economy.[20] The fiscal policy instruments equal their average values in the data over the period 2019-2021 to reflect fiscal conditions prior to the inflationary pressures that emerged in mid-2022 in Greece. Then, in order to investigate the effects of a reduction in the consumption tax rate, a temporary fiscal policy shock is introduced that reduces the consumption tax rate for a period of 12 quarters (3 years). The implementation period is chosen so as to reflect the typical duration of temporary fiscal measures adopted by many euro area countries in response to recent inflationary pressures.[21] The magnitude of the reduction is calibrated so that consumption tax revenues as a share of steady state GDP decline by 1 percentage point (p.p.) during the implementation period. After the three-year period, the tax rate gradually returns to its initial level, following a smooth adjustment path. Given that the shock is temporary, all macroeconomic variables will gradually converge to their initial levels.

The first part of the analysis focuses on the propagation mechanism of this shock. The objective is to understand how a temporary reduction in the consumption tax rate affects key macroeconomic variables. This experiment will serve as the baseline scenario. In the second part, the pass-through of the consumption tax cut to inflation is quantified. The degree of pass-through captures the extent to which changes in the consumption tax rate are transmitted to consumer prices, providing a concise measure of the policy's effectiveness in mitigating inflationary pressures.

In the third part, we explore how structural and policy-related factors influence the degree of pass-through. To this end, the baseline model economy is compared to alternative model configurations that vary in the following dimensions:

(i) Higher product market competition, to assess how firms' pricing power and tax responsiveness shape inflation dynamics.

(ii) Lower price adjustment frequency, testing whether nominal rigidities delay or weaken the transmission of tax changes to prices.

(iii) Reduced real wage rigidities, to evaluate how labour market flexibility alters the inflationary effects of tax policy.

(iv) Permanent (vs. temporary) tax cuts, to evaluate the role of policy persistence in shaping expectations and inflation.

(v) Stronger home bias in production (lower substitutability between domestic and imported intermediate inputs), to examine how reduced input substitution affects domestic price sensitivity to tax changes.

The selection of structural and policy-related factors for the sensitivity analysis is grounded in both theoretical considerations and empirical findings regarding the transmission of consumption tax changes. First, the degree of product market competition is known to influence the pricing behaviour of firms and the extent to which cost shocks are passed on to consumers. In more competitive markets, firms operate under tighter margins and price adjustments are more sensitive to cost shocks, including those induced by fiscal policy (see Lombardo 2002 and Fabiani et al. 2006). Second, the frequency of price adjustments determines the responsiveness of inflation to tax shocks. In models with Calvo frictions, more frequent price adjustments allow firms to update prices more rapidly, enhancing the short-run effectiveness of tax-based disinflationary policies. Third, lower wage rigidities facilitate faster adjustment in labour costs, thereby affecting the overall inflation response. Fourth, the persistence of the tax change alters agents' expectations and intertemporal decision-making. A persistent reduction

20 The values of the structural parameters are set as in Papageorgiou and Vourvachaki (2017) and Papageorgiou (2014).
21 See, e.g., Ferdinandusse and Delgado-Téllez (2024).

in the consumption tax rate may exert stronger effects on price-setting behaviour and consumption smoothing, as it is perceived to change the long-run relative price of consumption (see, e.g., Coenen et al. 2012). Finally, we consider the role of home bias in production, proxied as a lower substitutability between domestic and imported intermediate inputs. A stronger home bias implies that firms rely more heavily on domestically-produced intermediates. This channel is particularly relevant in small open economies, where the elasticity of substitution between domestic and imported inputs can significantly shape the transmission of both fiscal and external shocks (see, e.g., Burstein et al. 2003 and Corsetti et al. 2008).

All policy experiments are conducted under the assumption of perfect foresight, implying that households and firms fully anticipate the future paths of the fiscal shock.

3.3 TRANSITION DYNAMICS OF A TEMPORARY REDUCTION IN THE CONSUMPTION TAX RATE

Chart 3 displays the dynamic responses of selected macroeconomic variables to the fiscal policy shock, as derived from the model. All variables are expressed in percentage deviations from their steady state, except for the inflation rate, which is shown in percentage point changes. The propagation mechanism of the consumption tax shock is as follows:

The temporary reduction in the consumption tax rate increases households' disposable income, generating both a positive income effect and an intertemporal substitution effect in favour of higher current consumption. As a result, private consumption rises, stimulating aggregate demand and leading to an expansion of output in the short run. The lower consumption tax rate also reduces the relative price of consumption goods compared to investment goods, thereby lowering the relative price of capital. This weakens incentives to reallocate resources toward investment, leading to a decline in private investment. At the same time, employment increases, while real wages decline. The reduction in real wages compresses firms' real marginal costs, leading to an increase in labour demand, thereby allowing firms to decrease domestic prices. Consequently, domestic inflation falls. In turn, the decline in domestic prices improves the economy's terms of trade, stimulating a rise in exports, which further increases output. In the following periods of transition, as the consumption tax rate returns to its initial level, all variables gradually converge to their initial steady state.

3.4 PASS-THROUGH TO INFLATION

To quantify the inflationary impact of the consumption tax rate cut, we compute the cumulative present value pass-through to domestic prices. This measure captures the extent to which changes in the consumption tax rate are transmitted to domestic prices, by comparing the cumulative present value of inflation responses to the cumulative change in the consumption tax rate over a defined horizon. In particular, the cumulative present value pass-through T years after a change in the tax rate on consumption is defined as:

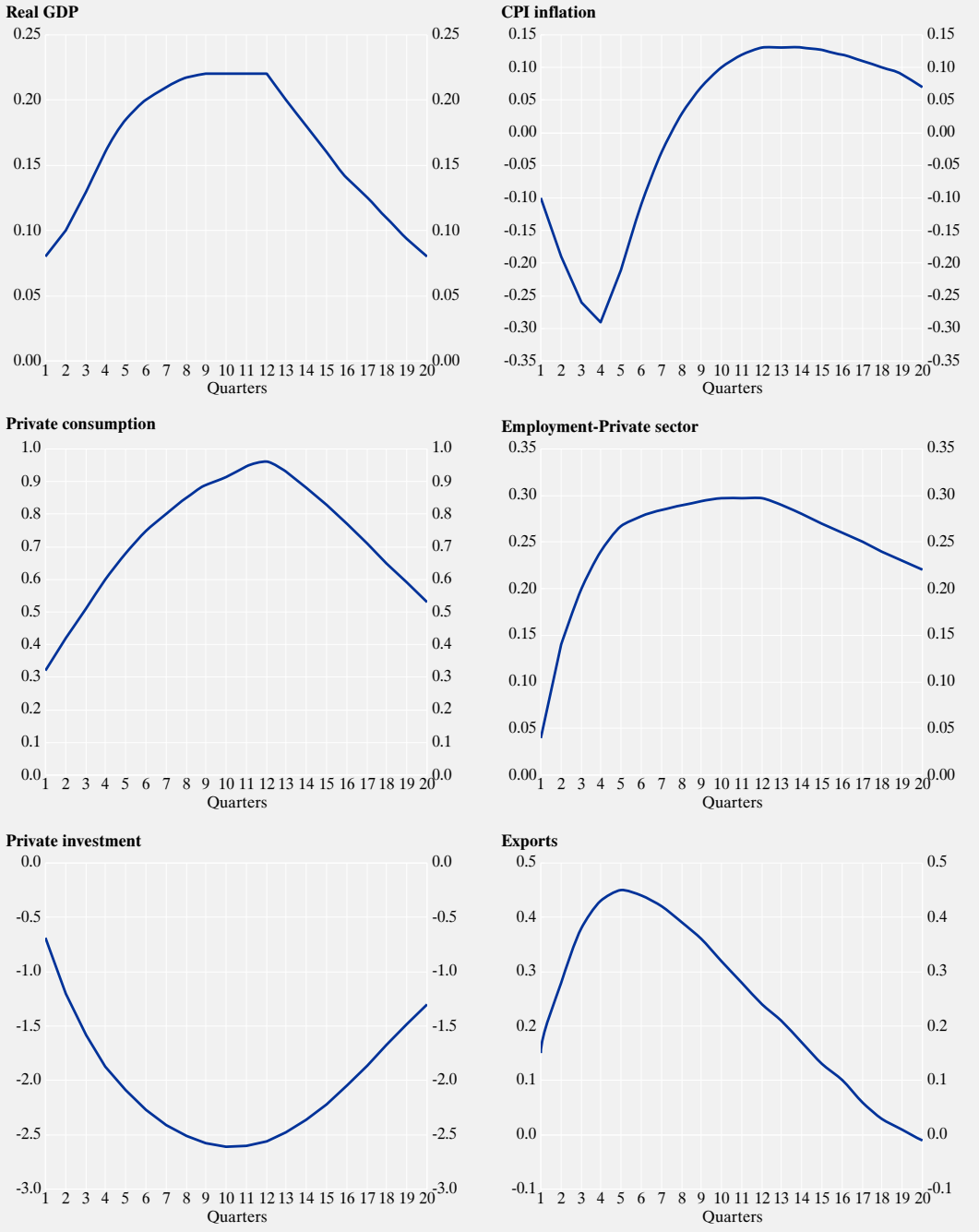
$$\varphi_t = \frac{\sum_{t=0}^{T}\left(\prod_{j=0}^{t}\left(R_{t+j}\right)^{-1}\right)\Delta CPI_{t+j}}{\sum_{t=0}^{T}\left(\prod_{j=0}^{t}\left(R_{t+j}\right)^{-1}\right)\Delta \tau^{c}_{t+j}} \qquad (2)$$

where ΔCPI_{t+j} and $\Delta \tau^{c}_{t+j}$ are, respectively, the level changes in CPI inflation and the consumption tax rate compared with their steady-state values and R_{t+j} is the model-based nominal return on government bonds, which is used as the discount rate.

The results indicate that the pass-through is partial, with the cumulative present value pass-through ranging between 25% and 19% during the first four quarters following the shock (see top left panel in Chart 4). This implies that, over the short term, approximately 19% to 25% of the reduction in the tax rate is reflected in lower consumer prices. The incomplete pass-through is in line with the findings of the empirical model under the baseline scenario and reflects the presence of nominal and real rigidities in the model, such as sticky prices and

Chart 3 Dynamic responses to a temporary reduction in the consumption tax rate

(%)

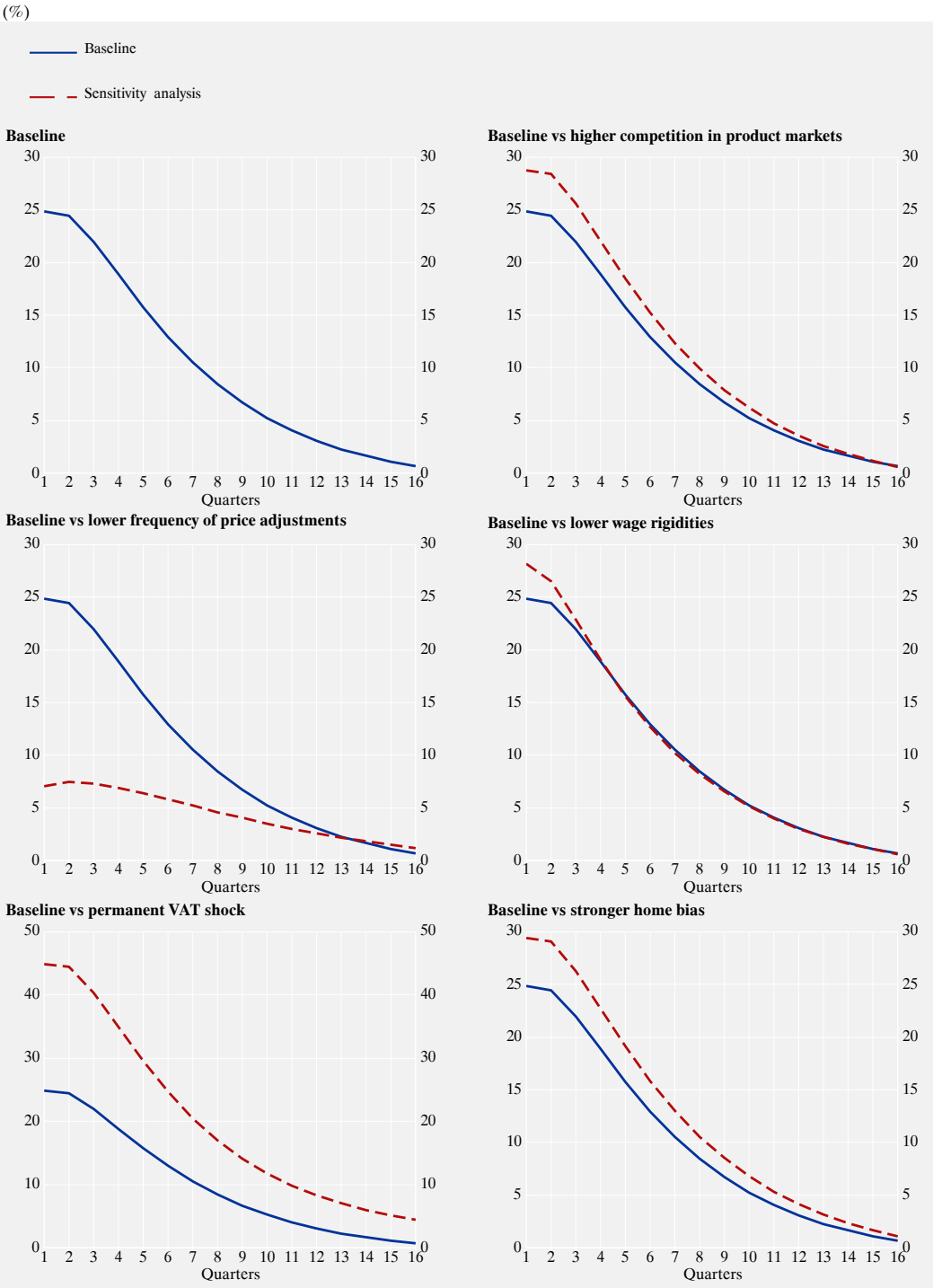


Source: Authors' estimations.
Note: All variables are expressed as percentage deviations from the steady state, with the exception of inflation, which is annualised and expressed in percentage point changes.

wage rigidities, which dampen the response of inflation to changes in tax policy.

There is limited evidence regarding the consumption tax rate pass-through to inflation in

Chart 4 Cumulative pass-through to inflation



Source: Authors' estimations.

the context of DSGE models.[22] Nevertheless, the dynamic responses of the macroeconomic

22 See Voigts (2016), who finds that the VAT pass-through to inflation depends on the modelling specification of consumption and VAT taxes.

variables are in line with previous studies that examine the general equilibrium effects of fiscal shocks using a similar framework (see, e.g., Forni et al. 2009; Coenen et al. 2008 and Kilponen et al. 2019). Compared to empirical estimates, the model-implied pass-through lies on the lower end of the spectrum. Most empirical studies, however, focus on sector-specific or product-level data, often examining the pass-through of value-added taxes to retail prices. These studies frequently report pass-through rates in the range of 30% to 100% in the short run, depending on the market structure, product type and timing of the tax change.[23] Unlike the empirical studies, the present analysis focuses on the aggregate macroeconomic effects of a broad-based consumption tax cut, rather than the micro-level adjustment of specific prices. This macro perspective captures general equilibrium effects and, unlike VAT, the consumption tax modelled here applies to a broader tax base, including all categories of private consumption, rather than a subset of goods and services.

3.5 STRUCTURAL AND POLICY DETERMINANTS OF THE CONSUMPTION TAX RATE PASS-THROUGH TO INFLATION

In this section, we conduct a series of sensitivity analyses to assess the robustness of the baseline results and shed light on the policy and structural factors that influence the transmission of consumption tax rate changes to inflation. These experiments isolate the role of key factors related to market structure, nominal and real rigidities, shock persistence and production openness, all of which may shape the extent to which tax changes are passed through to consumer prices. The results are illustrated in Chart 4.[24]

First, we consider the role of product market competition. Under a higher degree of product market competition (i.e. lower steady-state markups), prices are set closer to marginal cost, limiting firms' ability to absorb the effects of tax changes within their pricing margins. As a result, when the consumption tax is reduced and marginal costs fall, this change is fully reflected in prices, leading to a higher pass-through. While the differences are quantitatively modest, the results highlight how market power affects the responsiveness of inflation to tax changes: the disinflationary effect of the tax cut is stronger in more competitive economies, where lower markups increase the sensitivity of prices to tax rate changes.

Second, we examine the impact of nominal price rigidities by varying the frequency of price adjustments. When firms adjust prices less frequently —modelled through a higher Calvo parameter— the short-run pass-through of the consumption tax cut to inflation is significantly reduced. Infrequent price updating implies that only a fraction of firms can adjust their prices in response to the tax shock, leading to gradual and incomplete price adjustment at the aggregate level. In contrast, with more flexible pricing, a larger share of firms responds contemporaneously, allowing the tax cut to exert a stronger disinflationary effect. Consequently, the disinflationary effect of the tax cut is more muted in economies where firms adjust prices infrequently, as nominal rigidities delay the transmission of cost changes to final consumer prices. These findings are consistent with previous studies that emphasise the role of nominal rigidities in shaping the transmission of fiscal policy.

Third, we explore the implications of real wage rigidities for tax pass-through. When wages are more flexible, this enhances the responsiveness of inflation to tax changes. In this case, real wages adjust more rapidly in response to changes in labour demand and marginal costs, allowing firms to align their pricing more closely with tax-induced cost shifts. By contrast, when wages are rigid, firms face higher labour costs and the extent to which a tax cut lowers marginal costs is diminished, leading to a smaller price adjustment. This mechanism is in line with the broader macroeconomic liter-

23 See, for instance, Benedek et al. (2020) and Benzarti et al. (2020).
24 Table A2 in the Appendix summarises the values of the parameters used in the policy experiments.

ature highlighting the importance of labour market flexibility in macroeconomic adjustment (Christiano et al. 2005 and Smets and Wouters 2007). Thus, the pass-through to inflation is larger in economies with more flexible labour markets, as real wages adjust more rapidly to shocks, amplifying the impact on marginal costs and prices.

Fourth, we analyse the effect of the persistence of the tax shock. The results indicate that a permanent reduction in the consumption tax rate leads to a substantially higher pass-through than a temporary one, with the short-run pass-through rising to 35-45% in the first four quarters, nearly twice the level observed under a transitory shock. This amplification reflects the role of forward-looking behaviour: permanent tax cuts induce stronger responses in both consumption and prices. Firms respond to the sustained decline in marginal costs by implementing more pronounced price reductions, while households engage in stronger intertemporal substitution. As a result, the pass-through is significantly larger when tax changes are perceived as permanent. These findings are consistent with the fiscal policy literature emphasising the importance of expectations, credibility and the temporal structure of policy in shaping macroeconomic outcomes (see Leeper et al. 2010 and Coenen et al. 2013).

Finally, we consider the role of international input substitutability, by conducting a sensitivity analysis with respect to the elasticity of substitution between domestic and imported intermediate goods used in production. A lower elasticity implies stronger home bias, meaning firms rely more heavily on domestic intermediates. In this case, the reduction in real marginal costs is larger, as firms cannot easily substitute domestic with imported inputs, resulting in a stronger pass-through of the consumption tax cut to consumer prices. Conversely, when imported inputs are easily substitutable, firms can reallocate production toward foreign inputs, dampening the effect of the tax reduction. Hence, the inflationary effect of the tax cut is more pronounced in economies with stronger home bias in the use of domestic inputs in production. These results highlight the importance of production structure and input sourcing in shaping fiscal transmission, consistent with the findings of Burstein et al. (2003) and Corsetti et al. (2008).

In sum, the results suggest that the degree of tax pass-through is influenced not only by the tax instrument itself but also by key structural features of the economy, including market power, nominal and real rigidities, the persistence of policy interventions and the degree of openness in production. Understanding the interaction among these elements is crucial for the design of effective, tax-based inflation control strategies.

4 CONCLUSIONS

This paper investigates the effectiveness of VAT cuts in mitigating inflation in Greece through both empirical (SVAR) and theoretical (DSGE) approaches.

The empirical findings reveal that the direct impact of a VAT reduction on inflation is limited and statistically insignificant at the aggregate level. This suggests that there are modest short-term disinflationary effects under existing product market conditions. However, a significant and sustained fall in inflation is observed when VAT cuts are accompanied by improvements in product market competition.

The results from the DSGE model further demonstrate that the pass-through of consumption tax cuts to prices is partial (ranging from 19% to 25% in the short run) and highly dependent on structural and policy-related factors, such as market competition, labour market flexibility and the persistence of the policy intervention. Permanent tax cuts can nearly double the inflation pass-through relative to temporary measures, emphasising the role of policy credibility and forward-looking expectations in shaping macroeconomic outcomes. Moreover, the disinflationary effects of consumption tax cuts are amplified in more com-

petitive economies, where cost reductions are more readily transmitted to consumer prices. Conversely, in economies with high nominal rigidities or limited use of domestic inputs in production, the disinflationary effects are considerably muted.

Taken together, these findings suggest that reductions in the VAT rate alone may be insufficient as a tool for combatting inflation in Greece, as their effectiveness depends heavily on the country-specific institutional and structural context. Policy makers aiming to use consumption tax adjustments as a disinflationary instrument should therefore consider complementary reforms —particularly those that enhance competition and reduce structural rigidities— in order to maximise the transmission of tax changes to consumer prices. Future research could explore sector-specific VAT pass-through dynamics or the interaction between tax policy and monetary-fiscal coordination.

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APPENDIX

Table A1 Vector autoregression estimates

Sample (adjusted): 2001Q1 2024Q1

Included observations: 93 after adjustments
Restrictions: @VEC(L1) = "NA, NA, NA, 0, NA, NA, NA, 0, NA, NA, NA, 0, NA, NA, NA, 0, NA",
@VEC(L2) = "NA, NA, NA, 0, NA, NA, NA, 0, NA, NA, NA, 0, NA, NA, NA, 0, NA",
@VEC(L3) = "NA, NA, NA, 0, NA, NA, NA, 0, NA, NA, NA, 0, NA, NA, NA, 0, NA",
@VEC(L4) = "NA, NA, NA, 0, NA, NA, NA, 0, NA, NA, NA, 0, NA, NA, NA, 0, NA"
Iterated GLS convergence achieved after 6 iterations
Standard errors in parentheses and t-statistics in square brackets

	YT	PT_GR	MARKUP	STA_VAT
YT(-1)	0.529483 (0.1025) [5.16590]	0.047964 (0.03794) [1.26414]	-0.000217 (0.0004) [-0.54429]	0 –
YT(-2)	0.096392 (0.11741) [0.82102]	-0.00685 (0.04343) [-0.15772]	0.000253 (0.00047) [0.53927]	0 –
YT(-3)	-0.0209 (0.11562) [-0.18077]	0.004088 (0.04278) [0.09557]	[0.09557] (0.00046) [-0.36984]	0 –
YT(-4)	0.18847 (0.09889) [1.90590]	0.019879 (0.03657) [0.54355]	-0.000104 (0.0004) [-0.26059]	0 –
PT_GR(-1)	-0.522328 (0.28068) [-1.86095]	1.086396 (0.10383) [10.4635]	0.001555 (0.00113) [1.38039]	0 –
PT_GR(-2)	0.599941 (0.42138) [1.42376]	-0.155758 (0.15583) [-0.99954]	-0.001656 (0.00171) [-0.96803]	0 –
PT_GR(-3)	-0.347318 (0.42997) [-0.80777]	-0.421763 (0.15901) [-2.65248]	0.001208 (0.00175) [0.69235]	0 –
PT_GR(-4)	-0.045614 (0.298) [-0.15307]	0.137518 (0.11028) [1.24704]	-0.000924 (0.00118) [-0.78422]	0 –
MARKUP(-1)	12.89953 (26.5863) [0.48519]	7.159973 (9.84971) [0.72692]	0.820462 (0.09993) [8.21027]	0 –
MARKUP(-2)	21.98775 (31.7695) [0.69210]	0.693854 (11.7518) [0.05904]	0.021079 (0.12759) [0.16521]	0 –
MARKUP(-3)	8.437219 (31.6484) [0.26659]	-0.333966 (11.7084) [-0.02852]	0.332615 (0.12649) [2.62957]	0 –
MARKUP(-4)	-5.364481 (25.6125) [-0.20945]	10.99148 (9.48821) [1.15844]	-0.219792 (0.0966) [-2.27518]	0 –
STA_VAT(-1)	1.60226 (0.59929) [2.67358]	0.193709 (0.22487) [0.86142]	0 –	0.893084 (0.10099) [8.84303]
STA_VAT(-2)	-0.055079 (0.79942) [-0.06890]	-0.017447 (0.29999) [-0.05816]	0 –	0.012219 (0.13747) [0.08888]
STA_VAT(-3)	-0.131815 (0.79814) [-0.16515]	-0.075369 (0.29951) [-0.25164]	0 –	0.006911 (0.13744) [0.05029]
STA_VAT(-4)	-0.714838 (0.65289) [-1.09489]	0.222809 (0.24489) [0.90984]	0 –	0.02823 (0.09877) [0.28580]
C	-29.21883 (20.8429) [-1.40186]	-14.02434 (7.80403) [-1.79707]	0.01676 (0.01094) [1.53183]	1.498063 (0.54958) [2.72584]
EURIBOR3M	-0.030943 (0.27991) [-0.11055]	0.04221 (0.10374) [0.40689]	0.000909 (0.00113) [0.80440]	-0.088142 (0.03827) [-2.30300]

Source: Authors' estimations.
Notes: The above restrictions are operational and specific to the specification of the model. The above specification treats all input variables as endogenous (to produce impulse response functions) but with the assumed restrictions on statutory value added tax aimed to treat this variable as an exogenous variable.

Table A1 Vector autoregression estimates

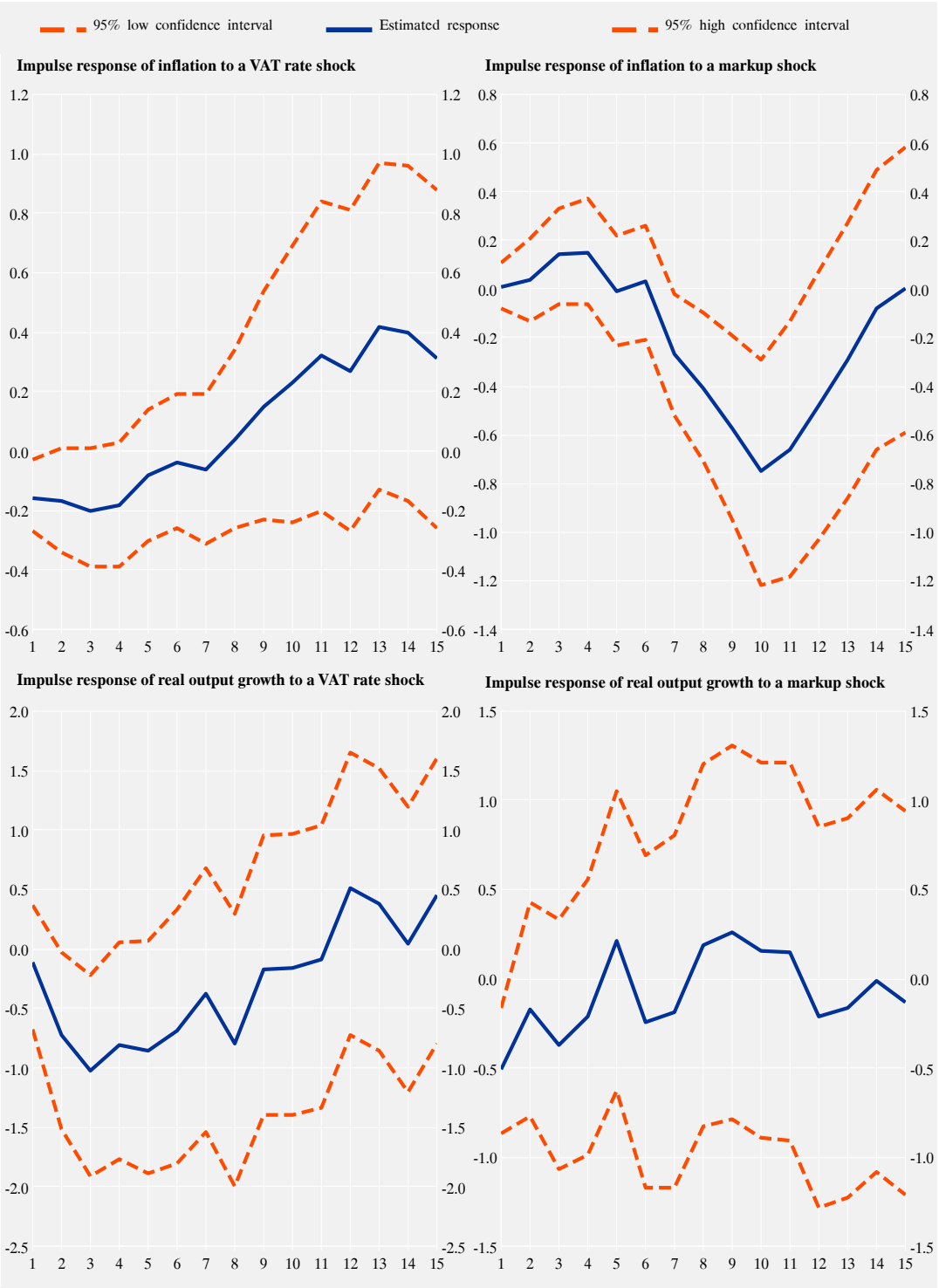
(continued)

R-squared	0.57617	0.835484	0.962604	0.970627
Sum sq. resids	509.0602	70.00788	0.008905	16.58047
Mean dependent	4.173903	2.684043	0.412138	21.5914
S.D. dependent	3.613225	2.150677	0.050875	2.47701
Determinant resid covariance		0.000152		
Log likelihood		-79.1481		
Akaike information criterion		2.906411		
Schwarz criterion		4.431417		
Number of coefficients		56		
Number of restrictions		16		

Source: Authors' estimations.
Notes: The above restrictions are operational and specific to the specification of the model. The above specification treats all input variables as endogenous (to produce impulse response functions) but with the assumed restrictions on statutory value added tax aimed to treat this variable as an exogenous variable.

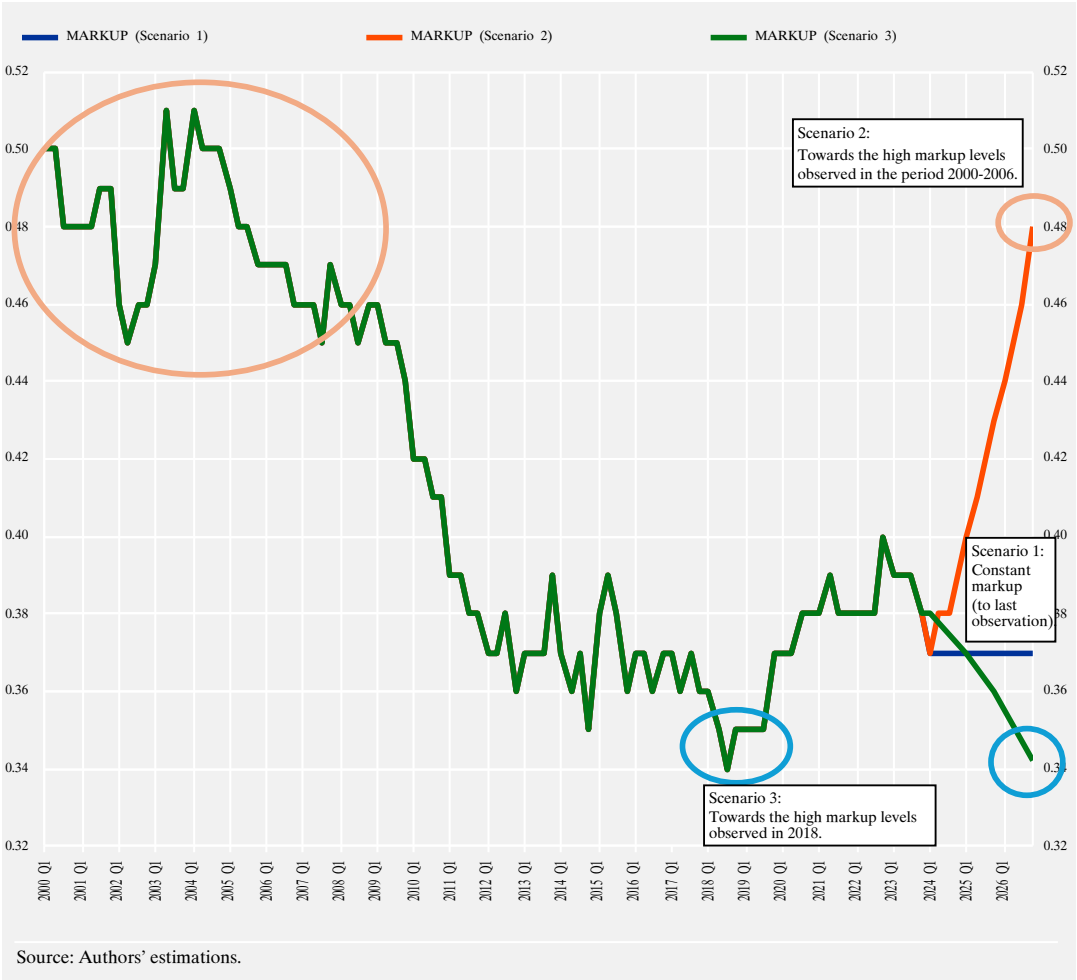
Chart A1 Local projections: impulse response function of inflation and growth to a negative shock to the statutory VAT rate and to markup (improvement in competition)

(response to Cholesky One S.D. Innovations 95.0% marginal confidence bands)



Source: Authors' estimations.

Chart A2 Graphical representation of markup evolution in the case of Scenarios 1, 2 and 3



Source: Authors' estimations.

Table A2 Calibrated parameters and sensitivity analysis

Parameter	Baseline calibration	Sensitivity analysis
Markups (domestic non-tradables)	1.463	1.263
Markups (domestic tradables)	1.352	1.152
Calvo parameters	0.75	0.90
Degree of real wage rigidity	0.70	0.20
Elasticity of substitution between foreign and domestically-produced tradable consumption goods	3.351	2.5
Elasticity of substitution between foreign and domestically-produced tradable investment goods	6.352	2.5

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ABSTRACT

In this paper, we use two waves of the cross-sectional Household Finance and Consumption Survey (HFCS) for 2018 and 2021 in order to construct a housing affordability index. The index is based on the ratio of housing costs to household disposable income at both national and regional level, as well as according to the degree of urbanisation. The evolution of the index and of the housing cost overburden rate indicates that housing affordability worsened from 2018 to 2021, while also revealing significant regional heterogeneity, with the issue being more pronounced in urban areas, particularly among renting households. Subsequently, the study identifies, through both descriptive and econometric evidence, the characteristics of the most vulnerable households, showing that younger and smaller in size households, the unemployed and those with lower income are facing the highest affordability constraints. Via these findings, the paper provides useful insights for the design of policies aimed to address the housing affordability issue.

Keywords: housing affordability; vulnerable households; housing markets

JEL classification: R21; R31; D31

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Η ΠΡΟΣΙΤΟΤΗΤΑ ΤΗΣ ΣΤΕΓΑΣΗΣ ΓΙΑ ΤΑ ΕΛΛΗΝΙΚΑ ΝΟΙΚΟΚΥΡΙΑ

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ΠΕΡΙΛΗΨΗ

Η παρούσα μελέτη, χρησιμοποιώντας διαστρωματικά δεδομένα από δύο κύματα της Έρευνας για τα Οικονομικά και την Κατανάλωση των Νοικοκυριών (Household Finance and Consumption Survey – HFCS) για το 2018 και το 2021, κατασκευάζει έναν δείκτη προσιτότητας της στέγασης, ο οποίος ορίζεται ως ο λόγος του κόστους στέγασης προς το διαθέσιμο εισόδημα των νοικοκυριών σε εθνικό και περιφερειακό επίπεδο, αλλά και ανάλογα με το βαθμό αστικότητας. Η εξέλιξη του δείκτη υποδηλώνει ότι η προσιτότητα της στέγασης μειώνεται μεταξύ 2018 και 2021, αλλά αναδεικνύει και την ιδιαίτερη ετερογένεια που υφίσταται μεταξύ περιφερειών, καθώς το ζήτημα είναι εντονότερο στις αστικές περιοχές και ιδίως για τα νοικοκυριά που ενοικιάζουν. Στη συνέχεια, η μελέτη δείχνει ότι τα νεαρότερα και μικρότερα σε μέγεθος νοικοκυριά, οι άνεργοι αλλά και τα νοικοκυριά με χαμηλότερο εισόδημα είναι εκείνα για τα οποία είναι οξύτερο το ζήτημα της προσιτότητας της στέγασης. Μέσω αυτών των ευρημάτων, η μελέτη παραθέτει χρήσιμες πληροφορίες που μπορούν να βοηθήσουν στη χάραξη πολιτικών για την αντιμετώπιση του ζητήματος.

† Απεβίωσε πριν από τη δημοσίευση του παρόντος άρθρου.

ΜΗ ΤΕΧΝΙΚΗ ΣΥΝΟΨΗ

Ο πιο κοινός ορισμός της προσιτότητας της στέγασης εκφράζεται ως το ποσοστό των νοικοκυριών το οποίο δαπανά πάνω από 40% του διαθέσιμου εισοδήματός του για την κάλυψη του στεγαστικού του κόστους. Σύμφωνα με τα τελευταία διαθέσιμα δεδομένα της Eurostat, για το 2023, η Ελλάδα βρίσκεται στη δυσχερέστερη θέση ανάμεσα στα κράτη-μέλη της Ευρωπαϊκής Ένωσης αναφορικά με το πόσο προσιτή είναι η στέγαση. Ενδεικτικά, στην Ελλάδα σχεδόν το 1/3 των νοικοκυριών σε αστικές περιοχές καταγράφεται να δαπανά πάνω από 40% του διαθέσιμου εισοδήματός του για την κάλυψη του κόστους που σχετίζεται με τη στέγαση, όπου συμπεριλαμβάνονται λογαριασμοί υπηρεσιών κοινής ωφέλειας, ενοίκια, πληρωμές στεγαστικού δανείου και δημοσιονομικά τέλη. Σε συνθήκες ανόδου των τιμών των ακινήτων και του κόστους ενέργειας και υψηλού κόστους δανεισμού, το στεγαστικό κόστος αυξάνεται σταδιακά, καθιστώντας τη στέγαση ακόμη λιγότερο προσιτή για τα εγχώρια νοικοκυριά. Ταυτόχρονα, οι δημόσιες δαπάνες για στέγαση, ως ποσοστό του ΑΕΠ, είναι για το 2022 από τις χαμηλότερες μεταξύ των κρατών-μελών. Ο συνδυασμός των συγκυριών αυτών αναδεικνύει τη σημαντικότητα του ζητήματος της προσιτότητας της στέγασης, καθώς οι αυξημένες δαπάνες των νοικοκυριών για στέγαση έχουν άμεσες κοινωνικές και οικονομικές επιδράσεις. Αφενός, τα ελληνικά νοικοκυριά καλούνται να προσαρμόσουν τα καταναλωτικά τους πρότυπα, δεδομένου ότι η ζήτηση στέγασης είναι γενικά ανελαστική. Αφετέρου, δυσχεραίνεται η συσσώρευση πλούτου μέσω αποταμιεύσεων, γεγονός που έχει άμεσες επιδράσεις στις επενδύσεις στην πραγματική οικονομία, αλλά και στο χρηματοπιστωτικό σύστημα.

Με αφετηρία τη σημαντικότητα της στέγασης και τη δυσμενή κατάσταση που αντιμετωπίζουν τα νοικοκυριά στην Ελλάδα, η μελέτη, χρησιμοποιώντας ως βάση την Έρευνα για τα Οικονομικά και την Κατανάλωση των Νοικοκυριών (Household Finance and Consumption Survey – HFCS), διερευνά την προσιτότητα της στέγασης σε εθνικό επίπεδο, ανά βαθμό αστικότητας και σε περιφερειακό επίπεδο, αλλά και για διαφορετικές κατηγορίες νοικοκυριών, με σκοπό να αναδείξει τις σημαντικές ετερογένειες που υπάρχουν και που μπορούν να αποτελέσουν χρήσιμη βάση για τη χάραξη στοχευμένων πολιτικών προς αντιμετώπιση του ζητήματος. Συγκεκριμένα, κατασκευάζουμε το δείκτη προσιτότητας της στέγασης, ο οποίος ορίζεται ως ο λόγος του στεγαστικού κόστους προς το διαθέσιμο εισόδημα για κάθε νοικοκυριό. Στη συνέχεια, για τον υπολογισμό του ποσοστού υπερεπιβάρυνσης από το κόστος στέγασης (Housing Cost Overburden Rate), ανάγουμε στο ποσοστό των νοικοκυριών τα οποία δαπανούν το 40% ή άνω του διαθέσιμου εισοδήματός τους για να καλύψουν το κόστος στέγασης και ως εκ τούτου δεν διαθέτουν πρόσβαση σε προσιτή στέγαση. Τα αποτελέσματα του δείκτη αρχικά αναδεικνύουν ότι η προσιτότητα της στέγασης μειώθηκε μεταξύ 2018 και 2021. Επίσης, παρατηρούνται σημαντικές διαφοροποιήσεις ανά βαθμό αστικότητας, με το ποσοστό των νοικοκυριών που δαπανούν πάνω από 40% του διαθέσιμου εισοδήματός τους (ποσοστό υπερεπιβάρυνσης από το κόστος στέγασης) να είναι υψηλότερο στις αστικές περιοχές σε σχέση με τις ημιαστικές και αγροτικές περιοχές. Μια κύρια διαφορά είναι η διάρθρωση των νοικοκυριών ανά καθεστώς ενοίκησης (ιδιόκτητη ή μισθωμένη κατοικία), καθότι οι ενοικιαστές είναι περισσότεροι στις αστικές περιοχές από ό,τι στις ημιαστικές ή αγροτικές περιοχές. Σε επίπεδο περιφερειών, αλλά και για τα δύο μεγαλύτερα αστικά κέντρα, το ποσοστό υπερεπιβάρυνσης από το κόστος στέγασης παρουσιάζει μεγαλύτερες διακυμάνσεις από το διάμεσο ποσοστό δαπανών για στέγαση, υποδηλώνοντας ότι η δυσχερέστερη πρόσβαση σε προσιτή στέγαση μπορεί να επηρεάσει και την εισοδηματική ανισότητα. Συγκεκριμένα, σε περιοχές όπως το Νότιο Αιγαίο, η Ήπειρος, η Αττική, η Θεσσαλονίκη και η Κεντρική Μακεδονία παρατηρούνται τα υψηλότερα ποσοστά νοικοκυριών χωρίς πρόσβαση σε προσιτή στέγαση. Τα αποτελέσματα αυτά, σε συνάρτηση με την εξέλιξη του κόστους στέγασης αλλά και του διαθέσιμου εισοδήματος, υποδηλώνουν ότι η άνοδος του ενεργειακού κόστους και οι δομικές αλλαγές στην σύνθεση των νοικοκυριών ως προς το καθεστώς ενοίκη-

σης είναι από τους βασικούς παράγοντες που συνέβαλαν στη μείωση της προσιτότητας μεταξύ των δύο γύρων της έρευνας, αλλά και στη γεωγραφική ετερογένεια.

Πέρα από τις διαφορές που προκύπτουν στην προσιτότητα της στέγασης ανά γεωγραφική περιοχή, η μελέτη εστιάζει στην αναγνώριση των χαρακτηριστικών των νοικοκυριών που αντιμετωπίζουν τα μεγαλύτερα εμπόδια πρόσβασης σε προσιτή στέγαση. Τα περιγραφικά αποτελέσματα της ανάλυσης δείχνουν ότι το ζήτημα της προσιτότητας της στέγασης: (α) σχετίζεται με το ιδιοκτησιακό καθεστώς της κατοικίας, το οποίο παρουσιάζει μεγάλη διακύμανση ανά περιφέρεια, με βάση το εύρημα ότι και στους δύο γύρους της έρευνας περίπου το 60% των νοικοκυριών που ενοικιάζουν δαπανά πάνω από το 40% του διαθέσιμου εισοδήματός του για την κάλυψη των στεγαστικών του αναγκών, (β) πλήττει εντονότερα τα νεαρότερα νοικοκυριά, (γ) οξύνεται όταν ο επικεφαλής του νοικοκυριού είναι άνεργος και, τέλος, (δ) σχετίζεται με την οικογενειακή κατάσταση, όπως επίσης και με το μέγεθος του νοικοκυριού. Πέραν των περιγραφικών ευρημάτων, μέσω ενός εμπειρικού υποδείγματος λογιστικής παλινδρόμησης η μελέτη εξετάζει τις επιδράσεις των χαρακτηριστικών των νοικοκυριών, αλλά και τις επιδράσεις από διαστρωματικές διακυμάνσεις των τιμών των ακινήτων, οι οποίες προκύπτουν από την επεξεργασία στοιχείων εκτιμήσεων ακινήτων που συλλέγει η Τράπεζα της Ελλάδος. Τα αποτελέσματα του υποδείγματος επιβεβαιώνουν ότι το μέγεθος των νοικοκυριών, η κατάσταση απασχόλησης και η ηλικία έχουν ισχυρές επιδράσεις στην πιθανότητα να αντιμετωπίζουν μη προσιτή στέγαση. Την πιο βαρύνουσα όμως, λόγω στατιστικής σημαντικότητας, επίδραση στην πιθανότητα έλλειψης προσιτότητας φαίνεται να έχει το καθεστώς ενοίκησης, καθώς ενοικιαστές και ιδιοκτήτες με στεγαστικό δάνειο έχουν πολύ υψηλότερες πιθανότητες να μην έχουν προσιτή στέγαση σε σύγκριση με τα νοικοκυριά που ιδιοκατοικούν. Επίσης, σχετικά με την αγορά κατοικιών, βρίσκουμε ότι το επίπεδο των τιμών των ακινήτων συσχετίζεται αρνητικά με την προσιτότητα της στέγασης. Το γεγονός ότι αυτά τα ευρήματα παραμένουν στατιστικά σημαντικά ακόμη και αφού χρησιμοποιηθούν και άλλες μεταβλητές ελέγχου, αλλά και μακροοικονομικές μεταβλητές σε επίπεδο περιφέρειας, επιτρέπει να αναδειχθούν οι σημαντικότεροι παράγοντες που επηρεάζουν την προσιτότητα της στέγασης και συνεπώς η μελέτη μπορεί να υποβοηθήσει τη χάραξη στοχευμένων πολιτικών.

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1 INTRODUCTION

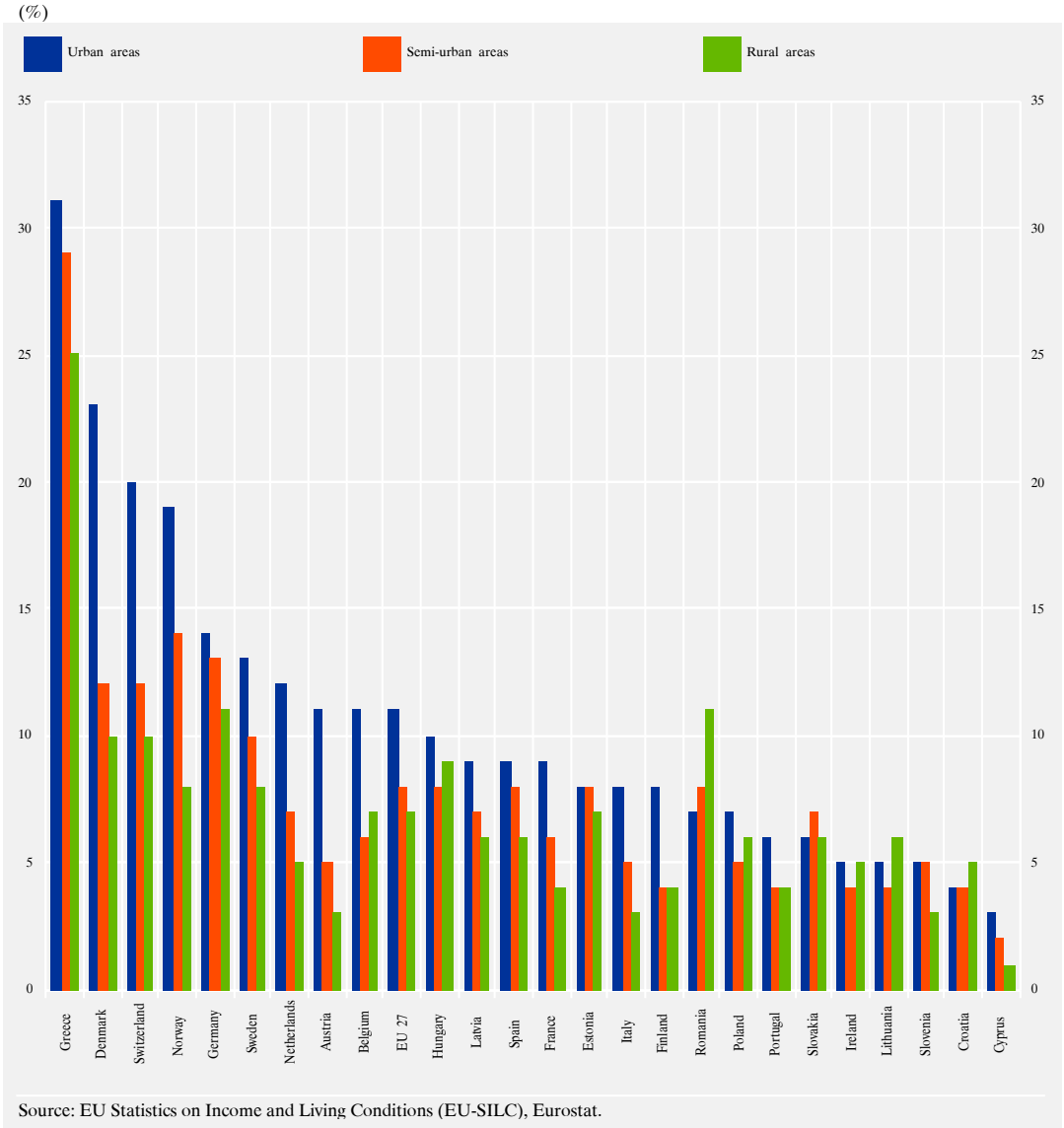
Housing is a fundamental pillar of both society and the economy, representing a network of essential human needs, economic stability and social well-being. Beyond its inherent value as a human right, housing has a profound impact on the economy. It is a key driver of consumer spending, as households allocate a significant portion of their income to housing expenses (Chambers et al. 2009; Iacoviello 2011). Furthermore, the housing sector encompasses a wide range of industries, thus contributing significantly to employment and economic growth (Muellbauer and Murphy 2008). Therefore, the availability of affordable housing allows households to adjust their consumption patterns (Anacker 2019) and be more resilient in meeting their financial obligations (McCord et al. 2011). Given the importance of housing affordability, this study is structured around three main themes: First, it presents a measure of housing affordability, harmonised across tenure status, as well as the housing cost overburden rate[1] at both the national level and across Greek prefectures, with a specific focus on the two largest urban centres, Athens and Thessaloniki. Second, it identifies the demographic and economic profile of Greek households facing the greatest difficulties in meeting their housing needs. Finally, it highlights the factors affecting housing affordability in Greece through an empirical analysis using household-level data.

In Greece, according to the latest available Eurostat data for 2023, households face significant budget constraints, largely due to the very high cost of housing relative to their income (Chart 1). Specifically, Greece ranks worst among EU Member States in terms of housing affordability, particularly in urban areas. According to EU Statistics on Income and Living Conditions (EU-SILC) data, in Greek urban areas, 31% of households spend more than 40% of their disposable income on housing costs, while, in rural areas, this percentage stands at 25%.[2] These findings are reinforced by the fact that government spending on housing in Greece is among the lowest in the European Union.

Housing affordability refers to the relationship between housing costs and household disposable income. Fluctuations in housing costs are directly affected by changes in property prices.

* The views expressed in this article are of the authors and do not necessarily reflect those of IOBE or the Bank of Greece. The authors are responsible for any errors or omissions. The authors wish to acknowledge the invaluable contribution of Dr. Sotirios Saperas, who passed away before the publication of this work.
† Deceased prior to the publication of this article.
1 The housing cost overburden rate is defined as the percentage of households that spend more than 40% of their disposable income in order to cover their housing costs. Housing costs include rent or mortgage payments, utility bills and fiscal taxes.
2 Housing costs include rent and lease payments, mortgage repayments and energy costs.

Chart 1 Housing cost overburden rate in Europe (2023)

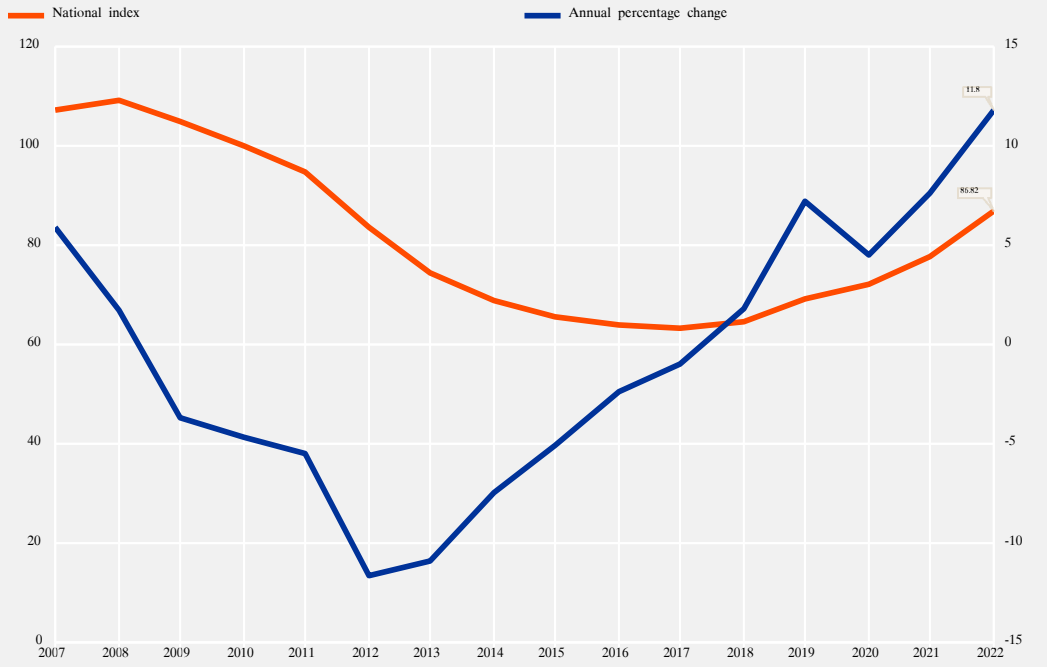


Source: EU Statistics on Income and Living Conditions (EU-SILC), Eurostat.

Apart from the underlying trends that drive house price developments, following significant declines during the Eurozone debt crisis (Vlamis 2013), prices in Greece have been on an upward trajectory since 2016. Furthermore, increased foreign direct investment in the real estate market and rising construction activity, particularly since 2018, indicate growing demand for housing, whether for residential or for commercial purposes (Chart 2), thereby exerting upward pressure on housing costs. Beyond rising property prices, housing affordability in Greece is further strained as the Price-to-Rent (PtR) ratio approaches pre-crisis levels (OECD 2023). Since the PtR ratio can signal potential market overheating, abrupt corrections could lead to an increase in non-performing loans, which would have direct negative consequences for the real economy. Furthermore, the Price-to-Income (PtI) ratio in Greece suggests that recent nominal income increases have not translated into equivalent purchasing power growth, due to high inflationary pressures, fuelling discussions for reg-

Chart 2 Evolution of house prices in Greece

(normalised index 2015=100; right hand scale: annual percentage change)



Sources: Bank of Greece and Eurostat.

ulatory interventions aiming to support households, while safeguarding the financial system through macroprudential measures targeting lenders (Bank of Greece 2023).

Additionally, international energy price hikes during the 2022-2023 period required households to allocate a larger share of their budgets to housing costs, ultimately making housing less affordable (Čermáková and Hromada 2022). Moreover, the monetary policy tightening during 2022-2023 aimed at curbing high inflationary pressures, increased borrowing costs (Gross and Souleles 2002; DeFusco and Paciorek 2017), thus discouraging Greek households from taking on more debt and imposing stricter budget constraints (Bank of Greece 2023). Also, potential credit protection measures, such as Loan-to-Value (LtV) or Loan-to-Income (LtI) ratio limits, intended to enhance the financial system's resilience, particularly in a prolonged period of rising house prices, could negatively impact household welfare by further restricting mortgage access (Balfoussia et al. 2018).

Moreover, on the supply side, the proliferation of short-term rentals is consuming an increasing proportion of the existing housing supply. Concurrently, a significant number of foreclosed properties —a legacy of past non-performing loans— remains vacant, exacerbating housing shortages and driving up prices. Finally, zoning regulations and the geographic distribution of housing supply are critical determinants of housing affordability (Glaeser and Gyourko 2002; Saiz 2010; Molloy 2020).

2 LITERATURE REVIEW

The first strand of the literature concerns the nature and characteristics of already existing housing affordability indices. A key challenge highlighted in the literature is whether a sin-

gle index can adequately capture the diversity of households (Jewkes and Delgadillo 2010; Cai 2017). As a result, various indices have been developed, such as the Self-Sufficiency Standard (Brooks and Pearce 2000), which measures the income required —without public or private subsidies— for a given family composition in a specific location to cover essential needs, including housing, healthcare and education. Similarly, the Shelter Poverty Index assesses whether a household's income is sufficient to meet non-housing needs after paying for housing costs. Another metric is the Amenity-Based Housing Affordability Index developed by Fisher et al. (2009), who argue that housing affordability should consider location factors, ensuring access to employment, education and other essential services. Beyond these, mostly qualitative, indices, the housing cost-to-income ratio is the primary metric for assessing affordability, due to its simplicity and accessibility. It is widely used by organisations such as Eurostat in Europe and the U.S. Department of Housing and Urban Development. The Housing Cost Overburden Rate, defined by Eurostat as the percentage of the population living in households that spend more than 40% of disposable income on housing, serves as a key benchmark for Eurostat across the EU. Similarly, the OECD Housing Cost Overburden Rate adopts the same 40% threshold to facilitate international comparisons. However, the use of threshold-based indices (e.g. 30% or 40% of income spent on housing) has limitations. Nelson et al. (2002) argue that these thresholds fail to distinguish between necessity and discretionary spending on housing. Fisher et al. (2009) highlight that spatial heterogeneity distorts affordability measurements, while Bogdon and Can (1997) criticise the neglect of qualitative housing changes over time. Despite these critiques, Schwartz and Wilson (2008) argue that the 30% threshold remains relevant for low-income households. While acknowledging these limitations, this study argues that, given the extensive sample size of the Household Finance and Consumption Survey (HFCS) and the simplicity of the index, the findings remain useful for cross-sectional analyses both within and across survey waves.

The second strand examines the socio-economic profile of households which experience the most significant housing affordability challenges, narrowing on low-income households (Lens 2018; Kropczynski 2012; Been et al. 2019; Gabriel and Painter 2020), renters (Mason et al. 2013; Luffman 2006; Anacker and Li 2016), single-parent households (Mulroy 1992; Cooper 2001) and young households (Zyed et al. 2016; Bujang et al. 2010).

The third strand investigates the determinants of housing affordability. Firstly, low interest rates and favourable credit conditions improve access to homeownership (Worthington and Higgs 2013; Torluccio and Dorakh 2011), whereas government policies, such as tax incentives, land use regulations and social housing programmes, also influence affordability (Lee et al. 2022). On top, macroeconomic factors that influence housing costs and affordability include energy prices, fiscal policies and wage trends (Coskun 2023; Biljanovska et al. 2023). Stronger economic growth and rising incomes improve affordability, while economic downturns and stagnant wages worsen it. Furthermore, inflationary pressures also increase both rental and homeownership costs, as well as construction and energy expenses. Lastly, because macroeconomic metrics do not vary significantly at regional levels, and our empirical analysis is based on pooled cross-sectional data over a short time frame, the inclusion of such metrics is expected to have limited explanatory power. However, controlling for variables such as gross domestic product and unemployment rates at the regional level allows for a more refined analysis of affordability trends.

3 DATA

As the study seeks to assess the socioeconomic status of households in terms of age, household

size, income, assets, employment and housing tenure, the primary data source is the Household Finance and Consumption Survey (HFCS), which, as far as Greek data are concerned, is compiled by the Bank of Greece as part of the Eurosystem's HFCS coordinated by the European Central Bank (ECB). The survey has been conducted four times – in 2009, 2014, 2018 and 2021.[3] Although not carried out annually, it provides valuable insights into housing affordability at both regional and broader geographical and administrative levels. Specifically, the HFCS contains extensive information on demographic and financial background, enabling an analysis of households experiencing the greatest financial constraints due to high housing costs, as well as an examination of the key determinants of housing affordability based on income and wealth characteristics.

For the construction of the housing affordability index, housing costs include mortgage payments for primary residences, rent payments, utility bills (water, electricity, heating) and property-related fiscal charges, such as the ENFIA property tax for homeowners. While most of these payments are already recorded in the HFCS dataset, additional primary data sources were integrated to estimate ENFIA. These include location-based factors, such as land zone prices, commercial coefficients, building frontage, floor level, surface area, building age and completion status. Based on these, the objective taxable value is calculated, allowing for an estimation of ENFIA costs for each household in the years corresponding to the HFCS survey waves.

Furthermore, to compute disposable income, as the HFCS only reports gross incomes, another primary dataset from the Bank of Greece was used, which records either net or gross household income on a monthly or annual basis. If only monthly income is reported, annual income is estimated based on the reported frequency of payments or by extrapolating to 12 months per year. Total household disposable income is then derived by aggregating different income sources, including wages, self-employment earnings, public and private pensions and unemployment benefits. For cases where only gross income is available, income tax rates, deductions and social security contribution rates are applied, based on income brackets, year, insurance contributions and number of dependents. Additional net income sources, such as financial transfers from relatives, rental income, dividends and capital gains are also incorporated. Summary statistics on the geographical distribution of household disposable income and housing costs are presented in the Appendix.

The second primary source of data consists of dwelling information, available from the Bank of Greece. This database includes properties whose values have been assessed by specialised appraisers from the four systemic banks in Greece. The use of these specific data is of particular importance for the study; as described in the empirical analysis section, property prices per prefecture are used as an independent variable, and the stratification differences arising from these will help us understand the impact of property prices on housing affordability per region. The hedonic methodology we employ is presented in the Appendix.

4 HOUSING AFFORDABILITY INDEX

The first step in constructing the housing affordability index is to determine the housing cost faced by each household in relation to its disposable income (Meen 2018; Suhaida et al. 2011). Subsequently, the corresponding housing cost overburden rate, as defined by Eurostat, is calculated as the percentage of households spending more than 40% of their income on housing costs. To formulate the housing affordability index, we follow the cost-to-income function of households and, more specifically, the methodology of Hick et al. (2024), where, in the

3 Due to differences in data collection for the first two waves and a lack of primary data regarding disposable income, contributions and taxes, our study focuses on the last two waves, i.e. 2018 (3rd wave) and 2021 (4th wave).

case of homeownership, the principal payments on household mortgages are included in the calculation of housing costs (in contrast to Eurostat's methodology for housing cost overburden).[4] By following this methodology, we ensure that the index is harmonised between renters and homeowners. A very important extension of this methodology is the geographical dimension of the index, as real estate market trends vary across cities, as well as between urban and rural areas. The housing affordability index is constructed as follows:

$$HAI_{i,w,r} = \frac{HC_{i,w,r}}{DInc_{i,w,r}},$$

where $HAI_{i,w,r}$ is the housing affordability index, representing the percentage of expenditure on housing for household i, in survey wave w and in geographical dimension r (degree of urbanisation or prefecture). *HC* and *DInc* are housing costs and disposable income, respectively. The only differentiation in the calculation of this ratio across tenure status lies in the numerator, with regard to the housing tenure status of the household. Specifically, for owner-occupied households, housing costs include mortgage costs, if any, electricity and water bills, and the cost of fiscal charges related to housing (e.g. ENFIA property tax for primary residences). Thus, another category of households is highlighted: those who are owners but with mortgage payments. For renters, this cost is determined by rent payments instead of mortgage payments.[5] Ultimately, for each region and degree of urbanisation, following the Eurostat methodology, we calculate the housing cost overburden rate, classifying households for which the *HAI* is above 40% as those with difficulties in access to affordable housing. Finally, we aggregate household data at the regional level and present the distribution of housing affordability by region.[6]

The results for the housing cost overburden rate reported in Table 1 are those that can be compared with the results for the housing cost overburden rate produced by Eurostat through EU-SILC data, by degree of urbanisation. While the metric is broadly comparable to that of Eurostat, the two indices have a fairly large divergence for the 3rd wave. Looking at the raw data of EU-SILC, this divergence does not stem from different dynamics between income and housing costs from 2018 to 2021 for the EU-SILC data. The overburden rate results initially indicate that the housing costs-to-income ratio is higher in urban areas than in semi-urban or rural areas. One of the reasons, as we will see

4 As constructed, higher affordability index (HAI) values indicate less access to affordable housing. The transformation of the index to the housing cost overburden rate is subsequently used to identify households with lack of affordable housing.

5 For homeowners, imputed rental payments are not included in their respective housing costs formula. The rationale is that we include only realised costs for the calculation of the housing affordability index.

6 The housing affordability index by each region represents the median household in order to reduce the effect of outliers in the calculation of the index.

Table 1 Housing affordability by degree of urbanisation

	Housing Affordability Index		Housing Cost Overburden Rate	
	3rd wave	4th wave	3rd wave	4th wave
Country total	24.0%	24.5%	28.7%	30.9%
Urban areas	25.0%	25.5%	30.2% (43.9%)	32.2% (32.4%)
Semi-urban areas	24.6%	23.3%	29.4% (41.3%)	28.8% (31.1%)
Rural areas	20.4%	21.2%	23.7% (31.7%)	27.7% (22.0%)

Sources: HFCS, Bank of Greece, and IOBE calculations.
Notes: The housing cost overburden rate is defined as the percentage of households that spend 40% or more of their disposable income on housing costs. The percentages in parentheses refer to historical Eurostat findings, based on a different database but the same degree of urbanisation. For the percentage of income spent, Eurostat does not publish data by degree of urbanisation. For the 4th wave, since the HFCS sampling took place between 2020 (30%) and 2021 (70%), we report Eurostat's findings for 2021.

Table 2 Housing cost overburden rate by degree of urbanisation and housing status

	3rd wave		4th wave	
	Owners	Renters	Owners	Renters
Country total	10.4%	59.2%	15.3%	60.1%
Urban areas	10.3%	62.0%	15.6%	62.0%
Semi-urban areas	11.9%	48.7%	13.2%	55.7%
Rural areas	10.1%	44.8%	15.7%	50.9%

Sources: HFCS, Bank of Greece, and IOBE calculations.
Note: The housing cost overburden rate is defined as the percentage of households that spend 40% or more of their disposable income on housing costs.

below, is the structure of households by housing (tenure) status in these areas, as renters represent a higher share of households in urban areas (32.3% and 44.8% in 2018 and 2021, respectively) than in semi-urban or rural areas (11.3% and 22.4% for the respective years in rural areas). Also, from 2018 to 2021, the housing cost overburden rate recorded an increase across all degrees of urbanisation.

Table 2 above presents the housing cost overburden rate by degree of urbanisation and housing status, where particularly large variations can be observed between renters and owners. Specifically, beyond an increase in unaffordability between the two waves, a large percentage of renters spent more than 40% of their disposable income to cover housing costs, which increases with the

Table 3 Housing affordability by region

	Housing Affordability Index		Housing Cost Overburden Rate	
	3rd wave	4th wave	3rd wave	4th wave
Athens	22.0%	23.0%	27.7%	28.2%
Eastern Macedonia and Thrace	25.2%	21.7%	36.1%	31.1%
Attica	24.4%	25.4%	24.0%	35.4%
Northern Aegean	23.9%	22.6%	28.7%	23.0%
Western Greece	23.8%	21.7%	31.8%	28.0%
Western Macedonia	31.0%	23.8%	45.7%	24.0%
Epirus	25.9%	31.4%	34.8%	38.0%
Thessaly	22.5%	24.5%	23.5%	32.2%
Thessaloniki	28.0%	30.6%	35.4%	35.0%
Ionian Islands	23.8%	26.0%	24.2%	31.1%
Central Macedonia	25.5%	23.1%	30.5%	34.6%
Crete	21.4%	27.3%	22.2%	32.5%
Southern Aegean	30.0%	29.4%	28.0%	45.7%
Peloponnese	20.5%	26.4%	24.6%	29.5%
Central Greece	20.5%	18.9%	21.5%	23.4%

Sources: HFCS, Bank of Greece, and IOBE calculations.
Notes: The housing cost overburden rate is defined as the percentage of households that spend 40% or more of their disposable income on housing costs. The percentage of income expenditure reported is at the median of the sample, so that the result is less prone to extreme values.

Table 4 Housing cost overburden rate by region and housing status

	3rd wave		4th wave	
	Owners	Renters	Owners	Renters
Athens	10.6%	60.1%	12.5%	61.0%
Eastern Macedonia and Thrace	21.3%	48.1%	16.0%	45.6%
Attica	9.9%	69.8%	20.0%	50.8%
Northern Aegean	1.4%	50.3%	10.5%	46.5%
Western Greece	15.1%	72.4%	13.1%	85.3%
Western Macedonia	30.6%	53.1%	6.8%	58.6%
Epirus	6.4%	55.9%	20.1%	59.6%
Thessaly	6.7%	74.0%	11.2%	55.9%
Thessaloniki	4.3%	64.2%	11.3%	68.1%
Ionian Islands	5.9%	37.0%	11.7%	69.6%
Central Macedonia	13.0%	58.1%	15.0%	40.5%
Crete	9.9%	61.7%	17.4%	85.3%
Southern Aegean	6.4%	60.6%	24.3%	58.9%
Peloponnese	4.9%	46.3%	13.4%	58.8%
Central Greece	7.0%	50.8%	9.8%	37.4%

Sources: HFCS, Bank of Greece, and IOBE calculations.
Note: The housing cost overburden rate is defined as the percentage of households that spend 40% or more of their disposable income on housing costs.

degree of urbanisation, from rural to urban areas.

At the regional level, and for the two largest urban centres, Table 3 presents the results for the median housing affordability index and the housing cost overburden rate. The results demonstrate uneven patterns in the evolution of housing cost expenditures across the Greek regions from 2018 to 2021. Specifically, regions such as Epirus, Attica, Crete, the Ionian Islands, the Peloponnese and Thessaloniki show an increase in median housing cost expenditures, while the remaining regions show either stagnation (Athens) or a decrease. The housing cost overburden rate rose in all regions except for Eastern Macedonia and Thrace, the Northern Aegean, Western Macedonia and Western Greece. The combination of these two findings —a marginal increase in the affordability index and an overall increase in the housing cost overburden rate— suggests that there were structural changes not only in housing costs and disposable income, but also in the household population structure and income inequality between the two waves of the survey, which may arise from an expansion of borrowing or a decrease in the rate of homeownership, among other factors.

Subsequently, Table 4 presents the results for the housing cost overburden rate by region and housing tenure. The results further highlight the affordability issues faced by renters, particularly in urban centres. However, these specific data should be interpreted with caution, due to the potentially small sample size per housing category and region. For example, in the 4th wave, the table's results for households renting in Western Macedonia are based on a sample of only 17 households.[7]

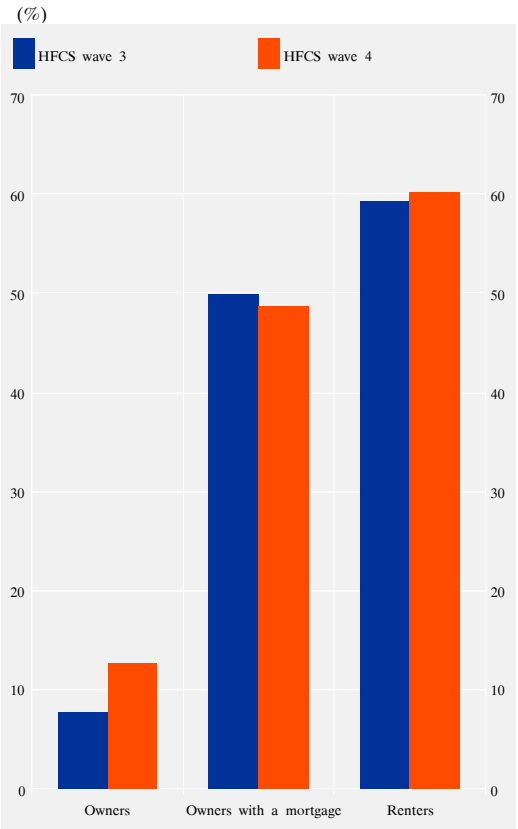
7 The data and analysis presented implement survey weights in order to calculate the aggregate statistics and regression outcomes.

5 DESCRIPTIVE EVIDENCE

In this section, we present descriptive evidence for households based on housing tenure, age group of the household representative, employment status, education level, marital status, household size and structure, and, finally, income level. For the 3rd and 4th waves, the results are shown in the charts below. Perhaps the most significant statistic exhibiting the greatest variation across household categories is housing tenure, given the differences in housing affordability between renters and owners with or without a mortgage for their primary residence (Chart 3). While the median expenditure of disposable income remained relatively stable between the 3rd and 4th waves, as did the measure of housing unaffordability, with only a slight increase in the latter for the 4th wave, the data indicate that renters are burdened much more heavily with housing costs, even compared to owners that make mortgage payments. It is particularly concerning that 60% of renting households, the majority of which reside in urban areas, spend over 40% of their disposable income to cover housing costs, making homeownership a hedge against the lack of affordable housing.

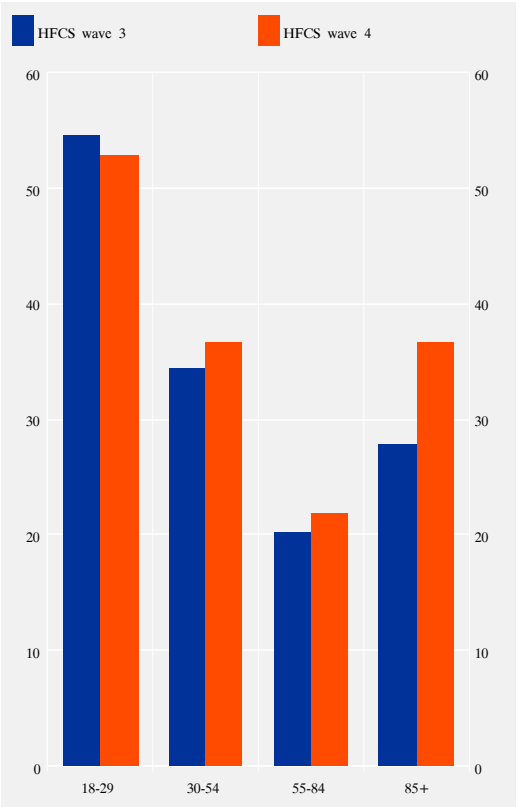
Next, we look at households across different age groups (Chart 4). Over half of households aged 30 or under have trouble accessing affordable housing. Housing affordability improves as households age but becomes more challenging for households aged 85 and over, likely due to lower incomes. However, as shown in

Chart 3 Housing affordability by tenure status



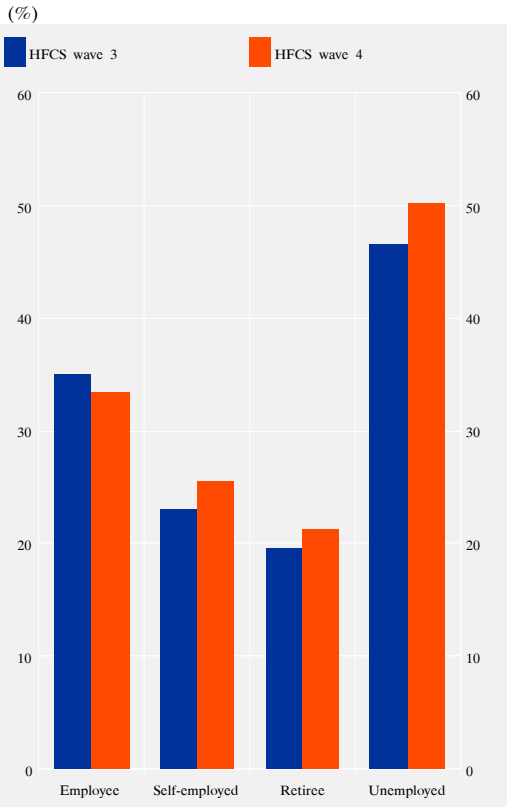
Sources: HFCS, Bank of Greece, and IOBE calculations.
Note: The housing cost overburden rate is defined as the percentage of households that spend 40% or more of their disposable income on housing costs.

Chart 4 Housing affordability by age group



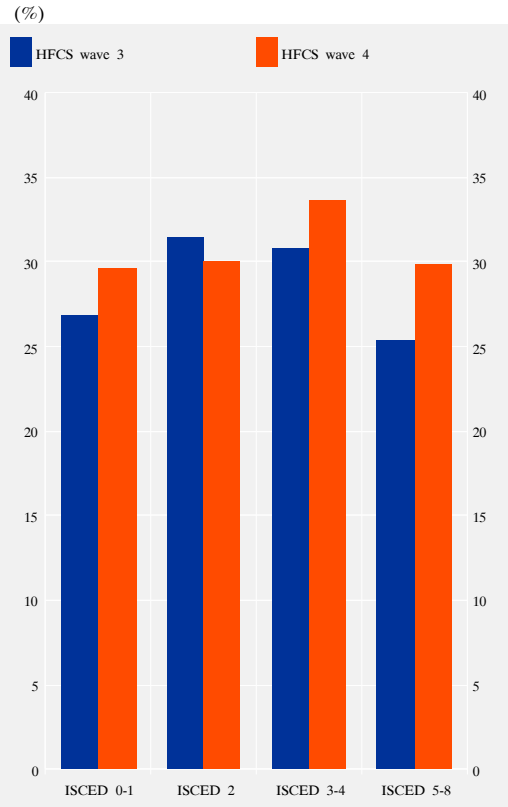
Sources: HFCS, Bank of Greece, and IOBE calculations.
Note: The housing cost overburden rate is defined as the percentage of households that spend 40% or more of their disposable income on housing costs.

Chart 5 Housing affordability by employment status



Sources: HFCS, Bank of Greece, and IOBE calculations.
Note: The housing cost overburden rate is defined as the percentage of households that spend 40% or more of their disposable income on housing costs.

Chart 6 Housing affordability by education level



Sources: HFCS, Bank of Greece, and IOBE calculations.
Note: The housing cost overburden rate is defined as the percentage of households that spend 40% or more of their disposable income on housing costs.

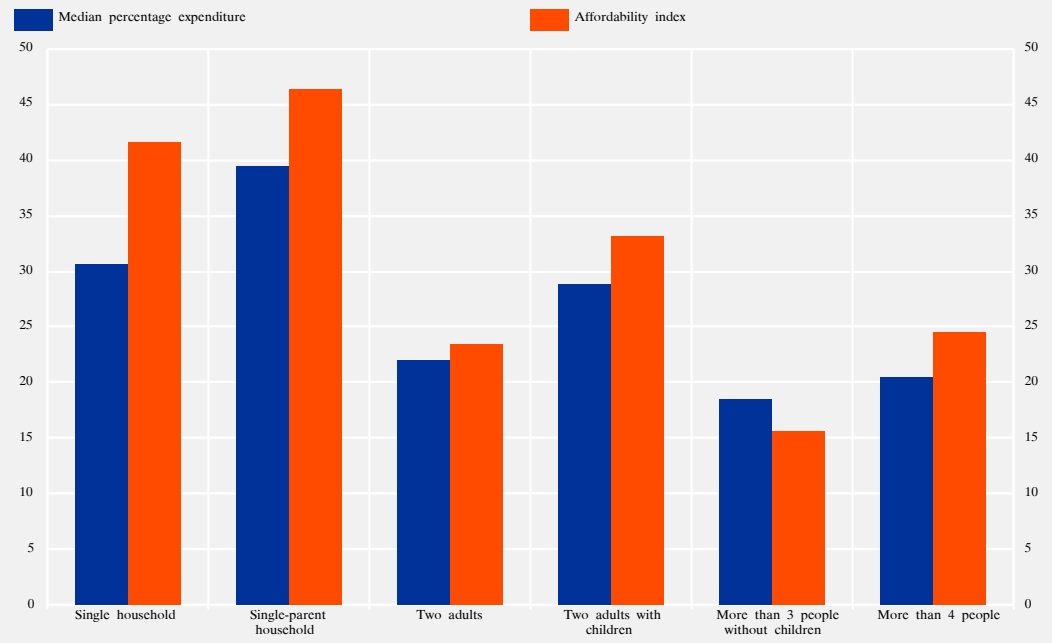
Chart 5, retirees have the easiest access to affordable housing compared to employees, self-employed individuals and the unemployed. This result makes the empirical analysis, which combines demographic characteristics, particularly important for understanding vulnerable households and prioritising policies. Subsequently, it is observed that the unemployed face the greatest challenge in accessing affordable housing, while employees spend 10 percentage points more on housing needs compared to the self-employed, likely due to lower incomes.

With regard to education level, Chart 6 illustrates a relative homogeneity in the percentage of disposable income spent on housing costs. As the education level is correlated with disposable income, households whose representative has completed more years of education spend a smaller percentage of their disposable income on housing. However, these percentages may also vary in relation to housing consumption, based on the square footage of home. According to the HFCS, the level of housing consumption, measured in square metres of the primary residence, increased by approximately 6.4% and 8.8% per person in the household for 2018 and 2021, respectively.

Furthermore, single-parent households face the greatest challenges in accessing affordable housing, followed by single-person households and then households with two adults with children, both in 2018 and particularly in 2021, when almost 70% of single-parent households spend over 40% of their disposable income to cover their housing costs (Chart 7). Generally,

Chart 7 Housing affordability by household size (HFCS wave 3)

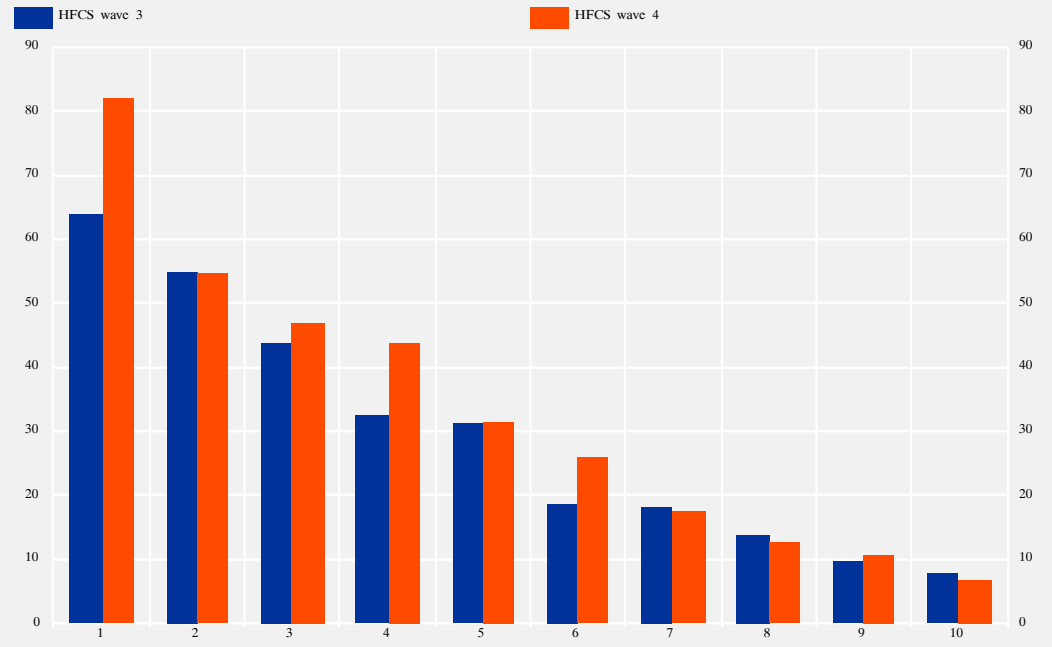
(%)



Sources: HFCS, Bank of Greece, and IOBE calculations.
Note: The housing cost overburden rate is defined as the percentage of households that spend 40% or more of their disposable income on housing costs.

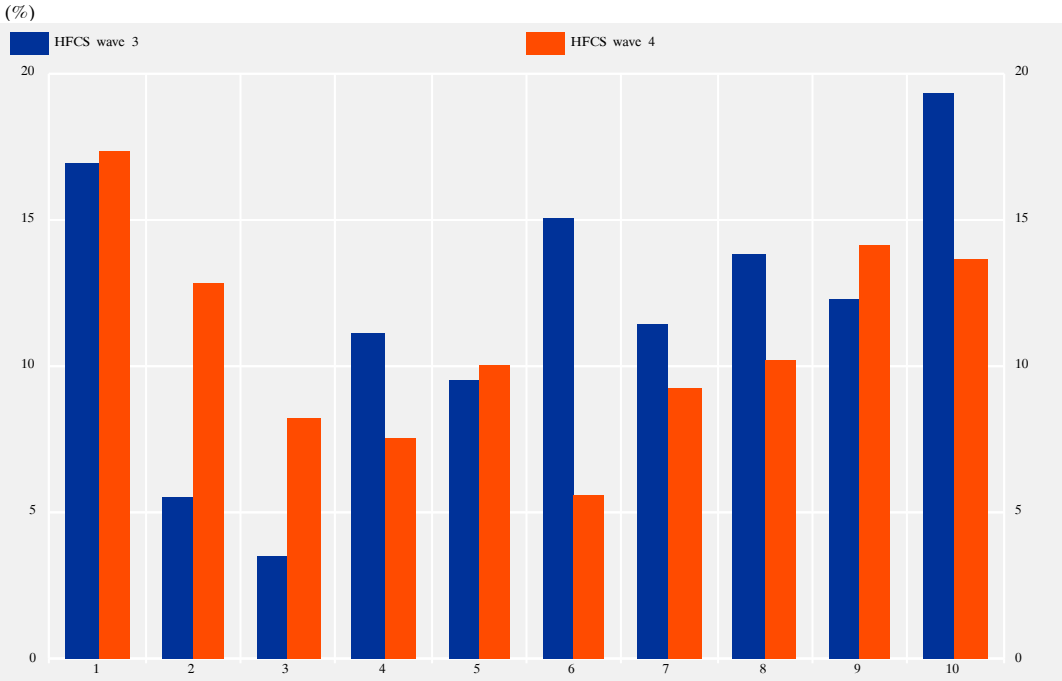
Chart 8 Housing affordability by income decile

(%)



Sources: HFCS, Bank of Greece, and IOBE calculations.
Note: The housing cost overburden rate is defined as the percentage of households that spend 40% or more of their disposable income on housing costs.

Chart 9 Percentage of homeowners with a first home mortgage by disposable income decile



Sources: HFCS, Bank of Greece, and IOBE calculations.

two trends are apparent: firstly, in relation to household size, the problem is particularly acute for single-person households, as well as for very large households of more than four adult members. Secondly, in relation to family status, the affordability issue is worse for families with children and especially for single-parent families.

Finally, Chart 8 presents the housing cost overburden rate per decile of the disposable income distribution. While the results are expected, i.e. as the income shrinks, the housing cost burden becomes higher, the findings in the middle of the distribution indicate that for households near the median, for 2021, the share of disposable income spent on housing declines disproportionately to income. This may suggest that these households either consume more housing (for every higher decile of disposable income housing consumption increases by approximately 4.5%, according to HFCS data for 2018 and 2021) or are homeowners with a mortgage among other things (Chart 9).

In conclusion, the descriptive evidence is in line with the findings presented in the literature. Households that rent, smaller and younger households, households with children and with precarious employment are those facing the most difficulties in access to affordable housing. In the empirical analysis that follows, the marginal effects of these variables on Greek households will be examined, further assisting in the development of policies to address the issue.

6 EMPIRICAL ANALYSIS

Having granular household-level data from the HFCS enables an empirical investigation of the impact of various factors on housing affordability at the microeconomic level. However, because the housing affordability index is constructed as the ratio of housing costs to disposable income, several socioeconomic characteristics of households are expected to be endogenous. For example, the employment

status of the household's representative directly impacts the evolution of their disposable income, which is a component of the housing affordability index. Therefore, we use a dummy variable to account for overburdened households, which takes a value of 1 when the household spends 40% or more of its disposable income to cover housing costs, and 0 otherwise. Such transformation is not expected to eliminate endogeneity; however, due to its lower variability, in the case of multicollinearity, this explanatory variable will not be included in the final estimation. Consequently, the methodology is a logistic regression model, which allows for the analysis of potential non-linear relationships.

Via the HFCS, a series of explanatory variables are employed regarding households' demographic and financial situation, as well as their estimates of the value of the property they reside in. Specifically, the key household-level characteristics, as reported by the household representative, are: age, divided into four distinct age groups (18-29, 30-53, 55-84 and 85+ years); marital status; employment status; household size; and highest level of education attained. Also, an important control variable is housing status, distinguishing between owners, owners with mortgage payments and renters. Furthermore, variables reflecting households' expectations regarding the evolution of their income and the price of their primary residence are used. Examining these specific variables allows for the assessment of potential biases held by households, which, however, can be a major driver of their consumption patterns. Regarding financial variables, we use variables such as household investments in financial products, e.g. stocks and bonds, the presence of outstanding credit card balances and consumer loans, and whether households have been denied credit. These specific variables are considered of lesser importance due to the lower participation rates of Greek households in the financial market and the low percentage of households with debt obligations. Furthermore, considering the significant impact of property prices on the differentiation of housing affordability, data on the estimated market values of properties from the Bank of Greece are used. As mentioned in the data section, the explanatory variable of property prices per square metre is the hedonic estimate at the regional unit (prefecture) level. In addition, a series of explanatory variables that can be used are publicly available macroeconomic variables (from Eurostat and the Bank of Greece), initially at the regional level, such as GDP per capita and the unemployment rate.

The general empirical methodology for a logit regression model with a binary dependent variable Y is typically of the form:

$$Pr[Y_i = 1|X1_i, \dots Xk_i] = \frac{1}{1 + \exp\left(-\sum_{j=1}^{k} \beta_j^0 X_{ji}\right)}$$

where one of the X_i equals 1 for the constant term and the β_j^0s are the true values of the parameters. This model is estimated using the maximum likelihood estimator and the coefficients of the variables can be interpreted as the log odds ratios. Subsequently, through logarithmic transformation, the average marginal effects of the variables on the probability of the variable Y taking the value of 1 are calculated as a function of the values of other variables. In our case, the value of the dependent variable $NAFF=1$ when the household, in line with Eurostat, spends more than 40% of its disposable income on housing needs. In a simplified analytical form, the logistic regression model adopted for estimating the marginal effects is as follows:

$$NAFF_i = \alpha + \sum_{h=1}^{H} \beta_h H_i + \gamma lnPS_n + \sum_{m=1}^{M} \delta_m M_{p,w} + \sum_{\substack{y \\ w=1}}^{w=2} \gamma_w Y_w + \sum_{n=1}^{N} \delta_n N_n + \varepsilon_i,$$

where the variable $NAFF_i$ equals 1 when access to housing for household i is considered unaffordable ($HAI_i \geq 0.4$). Subsequently, the various explanatory variables are separated into social, economic and financial characteristics of the households. In the model above, these characteristics are listed as the variable vector H.

These variables specifically, and according to the literature, are: age group, marital status, employment, education level, household size and housing tenure. Also, where available, we control for the effects of expectations regarding income and property price growth on the probability of unaffordable housing. The financial variables we use are whether the household holds stocks or bonds, has a credit card outstanding balance, loans and, finally, whether it has been fully or partially denied credit. Next, the variable *lnPS* represents the estimates of property values at the prefectural level *n*, from the hedonic pricing model. Finally, the variable vector *M* concerns macroeconomic-level variables, at the regional-prefecture level *p*, such as GDP per capita and the unemployment rate. Other variables which are at the national level, such as building permits, the size of the short-term rental collaborative economy based on data on the number of visits to short-stay accommodation and the average mortgage lending rate, were used in robustness checks. Yet, since these variables serve as further controls of the time effects, due to the reservations imposed by the cross-sectional nature of the data, the macroeconomic variables are differentiated by survey wave *w* and, ultimately, do not offer sufficient variability to provide additional explanatory power to the model. As additional controls, survey wave dummy variables *Y* were also used, which however are absorbed by the macroeconomic variables of GDP per capita and the unemployment rate but also at the prefecture level N_n. Finally, the residuals of the model are checked for heteroscedasticity and the regressions also take into account the household weights for the correct calculation of both the sample size and the standard errors.

For brevity, we show the results of the average marginal effects from a simpler to a more complex specification. This approach allows us to examine the magnitude and significance of each variable in the context of newly-added variables. Consequently, minor fluctuations in the size and significance of a variable suggest a robust effect on the probability of unaffordable housing. Table 5 presents the average marginal effects of independent variables on the probability of a household spending over 40% of its disposable income on housing (NAFF=1). Average marginal effects are estimated by first calculating the marginal effects for each household and then averaging these effects (coefficients). Starting with the age group, it is observed that, as the age of the household (or its representative) increases, the probability of unaffordable housing decreases, holding all other variables constant. Specifically, while in model (1) (see Table 5) households aged 30 to 54 are 14% less likely to have an affordability issue, households aged 55 to 84 and 85+ are approximately 26% and 24% less likely, respectively. However, focusing on model (3), which includes macroeconomic variables at the regional level and, more importantly, housing tenure, given that older households are more likely to be homeowners (77% and 94.5% respectively), the effect of age diminishes, although remaining statistically significant at the 95% confidence level. Specifically, while the oldest age group, due to a very high rate of homeownership, no longer has a statistically significant association with the probability of housing unaffordability, it is observed that the second oldest age group (30 to 54 years) and the third oldest (55 to 84 years) are 5% and 7.2% less likely, respectively, to face an issue of access to affordable housing, compared to the youngest age group of 18 to 29 years. This result is expected, as younger households have not yet had time to accumulate high incomes or wealth. The marital status of the representative of the household (married or single) does not appear to affect the probability of unaffordable housing, as none of the models record a statistically significant coefficient for the variable. However, model checks show that the effect of this variable is absorbed by the size variable, as married households are on average larger in size. With regard to employment status, while, marginally, the self-employed and retirees, compared to employees, do not show differentiated trends regarding their access to affordable housing, holding all other variables constant at

Table 5 Average marginal effects on the housing cost overburden rate

NAFF = 1	(1)	(2)	(3)	(4)	(5)
30 to 54 years old	-0.141***	-0.053*	-0.052*	-0.029	-0.028
	(0.031)	(0.030)	(0.029)	(0.034)	(0.031)
55 to 84 years old	-0.259***	-0.069**	-0.070**	-0.071*	-0.066*
	(0.038)	(0.035)	(0.035)	(0.037)	(0.035)
85+ years	-0.236***	-0.002	0.007	-0.010	0.005
	(0.059)	(0.059)	(0.059)	(0.059)	(0.057)
Married	0.008	0.008	0.008	0.015	0.015
	(0.026)	(0.023)	(0.023)	(0.020)	(0.019)
Self-employed	-0.063***	-0.011	-0.009	0.004	0.004
	(0.023)	(0.021)	(0.021)	(0.020)	(0.020)
Retired	-0.096***	-0.031	-0.024	0.005	0.008
	(0.027)	(0.024)	(0.024)	(0.022)	(0.021)
Unemployed	0.171***	0.147***	0.150***	0.151***	0.154***
	(0.029)	(0.026)	(0.026)	(0.024)	(0.024)
ISCED 2	-0.023	-0.030	-0.028	-0.046*	-0.045*
	(0.029)	(0.024)	(0.024)	(0.024)	(0.025)
ISCED 3-4	-0.070***	-0.054**	-0.057***	-0.052**	-0.051**
	(0.025)	(0.021)	(0.022)	(0.022)	(0.023)
ISCED 5-8	-0.121***	-0.098***	-0.101***	-0.088***	-0.086***
	(0.025)	(0.022)	(0.022)	(0.022)	(0.023)
Single-parent household	-0.013	0.007	0.004	-0.021	-0.015
	(0.065)	(0.044)	(0.046)	(0.042)	(0.041)
Two adults	-0.218***	-0.146***	-0.146***	-0.142***	-0.139***
	(0.029)	(0.026)	(0.026)	(0.026)	(0.026)
Two adults with children	-0.222***	-0.178***	-0.177***	-0.174***	-0.173***
	(0.038)	(0.034)	(0.034)	(0.031)	(0.030)
More than 3 people without children	-0.330***	-0.207***	-0.204***	-0.199***	-0.198***
	(0.028)	(0.029)	(0.028)	(0.027)	(0.027)
More than 4 people	-0.277***	-0.194***	-0.193***	-0.171***	-0.169***
	(0.041)	(0.039)	(0.039)	(0.038)	(0.036)
Homeowner with mortgage		0.441***	0.445***	0.448***	0.456***
		(0.032)	(0.031)	(0.032)	(0.030)
Renter		0.410***	0.412***	0.363***	0.373***
		(0.021)	(0.021)	(0.028)	(0.027)
Ln (property values by prefecture)			0.054*	0.093***	0.072**
			(0.031)	(0.029)	(0.035)
Ln (GDP per capita)			-0.080***	-0.086***	-0.160
			(0.030)	(0.031)	(0.357)
Unemployment rate			-0.006**	-0.010***	-0.011***
			(0.003)	(0.003)	(0.004)
Income expectations = Same				0.027*	0.024*
				(0.014)	(0.014)
Income expectations = Better				-0.097***	-0.100***
				(0.027)	(0.026)
Property value expectations = Same				-0.024	-0.019
				(0.018)	(0.018)
Property value expectations = Better				-0.064***	-0.057***
				(0.022)	(0.022)
Has stocks/bonds				0.219**	0.201**
				(0.089)	(0.082)
Has credit card outstanding balance				-0.063***	-0.057**
				(0.021)	(0.022)
Has consumer loan				-0.002	0.006
				(0.028)	(0.028)
Was denied credit				-0.030	-0.024
				(0.038)	(0.038)
Observations	5,365	4,758	4,758	3,842	3,842

Standard errors are in the parentheses: *** p<0.01, ** p<0.05, * p<0.1.

their averages, households whose representative is unemployed are approximately 15% more likely to spend over 40% of their income on covering their housing needs. The value of this variable when the household is unemployed remains statistically significant at the 99th percentile of significance regardless of the model, while its size also remains relatively stable, from 14.7% to 17.1%. This result is expected, as unemployed households have, on average, lower levels of disposable income in both waves of the survey. They also have the third highest average housing cost burden, after employees and the self-employed. This is consistent with the fact that retirees spend the smallest percentage of their income on covering their housing needs, as they are predominantly homeowners, as mentioned above, and are also not burdened by loan payments.

Another feature is that the probability of unaffordability decreases as the representative person of the household has more years of education, a relationship that is statistically significant in all models for International Standard Classification of Education (ISCED) levels 3 and above. According to model (3), graduates of upper secondary and post-secondary non-tertiary education (ISCED 3-4) are approximately 5.7% less likely to face an issue of housing affordability, while graduates of tertiary education up to and including doctoral degrees (ISCED 5-8) are about 10% less likely, compared to households where the representative person has completed up to primary education (ISCED 0-1). Looking at the demographic profile of the household, we observe that single-person and single-parent households are most likely to face an issue of housing affordability; as the size of the household increases, the probability of housing hardship decreases accordingly. More specifically, according to model (3), this probability decreases by approximately 15% when the household consists of two adults, almost 18% when they also have children and even more when the household consists of three adults without children (approximately 20% less likely to lack affordability). Finally, households consisting of four or more people (with the presence of children) are almost 20% less likely to face an issue of affordable housing. Lastly, beyond the demographic characteristics of households and how these affect the probability of lack of affordable housing, we examine housing tenure, which, based on the descriptive characteristics, also presents particularly large variation. The results are in line with the literature, as homeowners with a mortgage or renters have a much higher probability of facing housing constraints. In conclusion, we argue that the single most important household characteristic that imposes housing affordability constraints is the homeownership status of the household, as the coefficient of the tenure status remains highly significant across all the model specifications. Therefore, and also in line with the empirical evidence from other papers, the transition to homeownership provides a hedge against the lack of affordable housing due to higher housing costs or even shocks to household income.

7 CONCLUSIONS

Housing affordability in the Greek context poses a significant challenge to domestic households, more so than in any other Member State of the European Union, as evidenced by EU-SILC data. This study adds to the discussion by utilising HFCS data to analyse households' ability to meet housing needs amid rising property prices, costs and inflation. It constructs a harmonised housing affordability index that adds geographical granularity to Eurostat's findings, presents descriptive characteristics of households facing affordability issues and empirically analyses the probabilities of households facing such issues, using a logistic regression model. The study confirms the existence of a housing unaffordability issue, which worsened from 2018 to 2021, with significant regional heterogeneity. The combination of higher shares of income spent on housing and a rising housing cost overburden rate suggests

structural changes in housing costs, household incomes and population composition. More specifically, descriptive evidence and our empirical study reveal that renters, the unemployed, younger households, those with less education, and smaller households face the most barriers to affordable housing. Furthermore, in line with the findings of Eurostat releases, albeit at a higher geographical level, we find that the degree of urbanisation greatly affects housing affordability, as in urban areas, and especially in Greece's two largest cities, Athens and Thessaloniki, households are faced with increased housing costs in comparison to the rest of the country, making housing less affordable.

This study, drawing on descriptive and empirical evidence in line with international best practices, opens the discussion on several policy options to address Greece's housing affordability challenges. These might span from targeted support for vulnerable households through housing allowances and homeownership incentives to the strategic expansion of social housing programmes and the strengthening of real estate market regulations to stabilise rental and housing markets, while increasing supply. Furthermore, while Greece's current social housing policy primarily relies on housing benefits, revising income criteria is essential for improving the efficacy of those programmes. Another option could be to normalise the real estate market through enhanced tenant protections (as in Sweden and Germany). Addressing supply-side issues includes offering long-term visibility on building rules and zoning regulations, simplifying real estate transfer procedures, as well as mitigating the impact of vacant housing and the short-term rental market or the effects from the Golden Visa programme, as evidenced by Portugal's recent policy changes. Other ways to deal with the issue could be via the collection and monitoring of rental lease data, as international examples demonstrate the effectiveness of robust lease agreement data collection; tax incentives for official registration of vacant properties or a tax thereon; and targeted tax reforms to stimulate rental market investment. Ultimately, housing in Greece represents a significant financial burden for many households, impacting their consumption, wealth accumulation and resilience to economic shocks. A comprehensive and balanced policy approach is therefore essential.

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APPENDIX

HEDONIC PRICING METHODOLOGY

The data from the Bank of Greece include detailed information on all types of residences (apartments and houses) for which there has been a mortgage application to a Greek commercial bank, from 2006 to 2023. To reduce the impact of extreme values, we follow the methodology of the Bank of Greece by removing properties smaller than 15 square metres and larger than 400 square metres. Additionally, from this specific sample, we remove observations below the upper limit of the 1st and above the 99th percentile, using the price per square metre as the criterion.

These data are analysed through hedonic pricing methods, which control for differences in sample quality over time and also remove temporal trends (Hill 2013 and Eurostat 2013, among others). Thus, we arrive at a price per square metre by prefecture, which is the estimator of the average price of the sample. Below, we present the hedonic price index methodology, which controls for changes in the sample, but also, as the indices are constructed exclusively for each prefecture (NUTS3), they allow for different covariate pricing.[i]

$$lnPS_{i,y,q} = \alpha_0 + \sum_{x=1}^{X} \beta_x X_{i,y,q} + \sum_{y=1}^{Y} \gamma_y Y_y + \sum_{q=1}^{Q=4} \delta_q Q_q + \varepsilon_{i,y,q}$$

where, for each property i in year Y_y and quarter Q_q, the dependent variable is the natural logarithm of the price per square metre $lnPS$. The adjustment initially takes into account the X characteristics of the residence, such as the type of residence, the floor and the year of construction. Regarding the vector X, the database contains a multitude of additional variables but we end up with a model without many explanatory variables of property characteristics, so as not to lose information from variables for which there is little data available. For the year of construction, we resort to a binary variable that groups observations that do not record a year of construction, so as not to lose almost 50% of the sample (147 thousand observations). Subsequently, the vectors of variables Y_y and Q_q are control variables for temporal trends for the year and quarter, respectively. The standard errors of the equation take into account heteroskedasticity but are also grouped by postal code to control for spatial autocorrelation.

In a second step, through the estimates of the coefficients, for each property i, the prediction of $\widehat{PS}$ is estimated, in average values for each independent variable:

$$ln\widehat{PS}_{i,y,q} = \hat{\alpha}_0 + \sum_{x=1}^{X} \hat{\beta}_x \bar{X}_{i,y,q} + \sum_{y=1}^{Y} \hat{\gamma}_y \bar{Y}_y + \sum_{q=1}^{Q=4} \hat{\delta}_q \bar{Q}_q$$

The property price index for each period and by prefecture ultimately results from the average of the adjusted estimated prices.

$$\widehat{PS}_y = {}^{1}/_{N} \sum_{i=1}^{N} \exp\left(\widehat{PS}_{i,y}\right)$$

i According to the typology of the European Union (NUTS3), the number of prefectures is 52.

AUXILIARY TABLES

Table A1 Structure of housing cost and disposable income variables

Housing Cost	Source	Level
First home loan instalment[1]	HFCS	Monthly (converted to annual)
Rent payment[3]	HFCS	Monthly (converted to annual)
Utility costs (electricity, water, gas, telephone, internet and television)[1,2,3]	HFCS	Monthly (converted to annual)
Fiscal fees (ENFIA)[1,2]	Bank of Greece	Annual (authors' estimates)
Disposable income		
Salaried employees	HFCS – Bank of Greece	Monthly (converted to annual), Gross (converted to net)
Self-employed	HFCS – Bank of Greece	Monthly (converted to annual), Gross (converted to net)
Public pensions	HFCS – Bank of Greece	Monthly (converted to annual), Gross (converted to net)
Private pensions	HFCS – Bank of Greece	Monthly (converted to annual), Gross (converted to net)
Unemployment benefit	HFCS – Bank of Greece	Monthly (converted to annual), Gross (converted to net)
Other income		
Income from regular private transfers	HFCS – Bank of Greece	Monthly (converted to annual), Gross (converted to net)
Financial assistance from relatives and friends	HFCS – Bank of Greece	Monthly (converted to annual), Gross (converted to net)
Gross income from property rentals	HFCS – Bank of Greece	Monthly (converted to annual), Gross (converted to net)
Gross income from financial investments	HFCS – Bank of Greece	Monthly (converted to annual), Gross (converted to net)
Gross income from private business other than self-employment	HFCS – Bank of Greece	Monthly (converted to annual), Gross (converted to net)
Gross income from other sources of income	HFCS – Bank of Greece	Monthly (converted to annual), Gross (converted to net)

1 Refers to owners with a mortgage for their primary residence.
2 Refers to owners without a mortgage for their primary residence who are not burdened with mortgage payments.
3 Refers only to households that rent the space they live in.

Table A2 Number of households by region and wave of the HFCS

	Survey wave	
	3rd wave – 2018	4th wave – 2021
Country total	3,007	3,338
Athens	936	1278
Eastern Macedonia and Thrace	163	190
Attica	218	249
Northern Aegean	90	105
Western Greece	157	139
Western Macedonia	67	54
Epirus	88	158
Thessaly	203	137
Thessaloniki	183	240
Ionian Islands	57	96
Central Macedonia	271	241
Crete	145	84
Southern Aegean	135	110
Peloponnese	129	170
Central Greece	165	135

Sources: HFCS, Bank of Greece, and IOBE calculations.
Notes: The table refers to the sample of households. Each household is assigned a weight, which scales the sample to the total population of households in Greece. The descriptive data, as well as the empirical analysis, include the weights of the households in their calculations.

Table A3 Annual disposable income of households by region and wave of the HFCS

(EUR)

	Survey wave			
	3rd wave – 2018		4th wave – 2021	
	Mean	Median	Mean	Median
Country total	14,681	13,039	16,573	14,400
Athens	15,058	12,792	18,671	16,800
Eastern Macedonia and Thrace	14,132	12,285	15,058	13,219
Attica	13,936	12,505	16,361	14,196
Northern Aegean	12,873	11,451	15,064	13,300
Western Greece	14,254	13,538	15,248	15,000
Western Macedonia	13,872	12,251	13,390	12,399
Epirus	13,902	11,612	13,840	12,343
Thessaly	16,713	15,069	17,441	15,624
Thessaloniki	14,526	12,701	16,098	13,802
Ionian Islands	13,461	11,880	15,792	14,000
Central Macedonia	12,444	10,910	15,593	13,864
Crete	17,701	15,469	17,666	15,142
Southern Aegean	12,886	11,928	17,378	13,344
Peloponnese	14,899	13,920	16,579	12,416
Central Greece	15,076	13,880	18,678	16,009

Sources: HFCS, Bank of Greece, and IOBE calculations.
Note: With a view to reducing the variance of the sample and the effect of extreme values on the calculation of the affordability index, but also in order to maintain the same statistical treatment, observations falling within the bottom and top percentiles have been removed.

Table A4 Annual housing costs of households by tenure status, region and wave of the HFCS

(EUR)

	3rd wave – 2018				4th wave – 2021			
	Renters		Owners		Renters		Owners	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
Country total	5,029	4,800	3,246	2,694	5,967	5,568	3,778	3,239
Athens	5,056	4,800	3,216	2,678	6,579	6,336	3,890	3,277
Eastern Macedonia and Thrace	4,595	4,800	3,435	2,744	5,236	5,040	3,347	2,727
Attica	5,381	5,400	3,069	2,612	5,929	6,000	3,746	3,229
Northern Aegean	4,256	4,260	2,607	2,503	5,114	4,800	2,875	2,639
Western Greece	4,466	4,440	3,624	2,757	5,138	4,800	3,376	2,779
Western Macedonia	4,517	3,600	3,839	3,226	4,885	4,656	3,212	2,637
Epirus	4,919	4,800	2,831	2,244	5,548	5,400	3,244	2,669
Thessaly	5,462	5,040	3,791	2,733	5,706	5,400	4,041	3,348
Thessaloniki	5,096	5,160	3,209	3,032	6,188	6,000	4,053	3,339
Ionian Islands	5,072	4,440	2,447	2,171	5,758	5,520	3,586	2,838
Central Macedonia	4,455	4,200	3,075	2,619	5,125	4,800	3,292	2,728
Crete	5,123	4,920	3,459	3,269	6,141	5,705	5,006	3,989
Southern Aegean	5,709	6,000	3,043	2,678	5,708	5,352	4,242	3,698
Peloponnese	4,973	4,800	2,983	2,578	6,201	6,000	3,657	3,262
Central Greece	5,405	5,760	3,009	2,613	5,585	5,400	3,513	2,705

Sources: HFCS, Bank of Greece, and IOBE calculations.
Note: With a view to reducing the variance of the sample and the effect of extreme values on the calculation of the affordability index, but also in order to maintain the same statistical treatment, observations falling within the bottom and top percentiles have been removed.

Table A5 Median housing consumption, measured in square metres of floor area, by survey wave and tenure status

	3rd wave			4th wave		
	Total	Renters	Owners	Total	Renters	Owners
Country total	81	70	86	85	70	90
Athens	77	65	80	80	70	85
Eastern Macedonia and Thrace	85	68	90	90	78	98
Attica	85	75	90	90	70	95
Northern Aegean	74	60	80	80	70	80
Western Greece	90	80	90	90	70	90
Western Macedonia	88	80	90	85	70	90
Epirus	82	70	98	80	70	85
Thessaly	90	75	96	100	80	108
Thessaloniki	75	70	77	75	65	81
Ionian Islands	75	70	85	90	68	100
Central Macedonia	85	70	90	80	70	85
Crete	90	65	90	80	64	82
Southern Aegean	80	75	80	80	58	85
Peloponnese	85	80	93	88	78	90
Central Greece	90	80	96	90	80	92

Sources: HFCS, Bank of Greece, and IOBE calculations.

Table A6 Descriptive statistics of explanatory variables

Variable	Observations	Mean	Standard Deviation	Min	Max
Demographic variables					
Age group	6,121	2.418	0.659	1	4
Marital status	6,121	0.596	0.491	0	1
Employment status	5,365	2.137	1.091	1	4
Education level	6,121	2.768	1.032	1	4
Household size	6,121	3.208	1.531	1	6
Housing status and expectations					
Housing status	5,448	1.539	0.834	1	3
Income expectations	5,897	1.765	0.473	1	3
Property price expectations	4,864	1.908	0.603	1	3
Financial variables					
Stocks/Bonds	6,121	0.009	0.097	0	1
Credit card outstanding balance	6,121	0.055	0.228	0	1
Consumer loan	6,121	0.055	0.228	0	1
Credit denial	6,121	0.014	0.118	0	1
Property prices					
Logarithm of property value per sq.m. (by Prefecture, NUTS3)	6,121	6.886	0.274	6.217	7.555
Macroeconomic variables					
Logarithm of GDP per capita (NUTS2)	6,121	9.701	0.272	9.278	10.056
Unemployment rate (NUTS2)	6,121	17.451	2.491	14.914	19.896

Sources: HFCS, Bank of Greece and Eurostat.
Note: The statistics listed in the table are weighted to the population.

THE LONG RECORD OF INFLATION SHOCKS IN GREECE: DRIVERS AND IMPACTS

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ABSTRACT

Global geopolitical tensions have increased considerably in recent years. This has affected the economies primarily via prices on commodities. As a result, global inflation has risen in the aftermath of geopolitical shocks. Given the higher energy and food price shares in the consumer basket, Greek inflation has also risen significantly. Historically speaking, Greece has repeatedly experienced periods of inflationary pressure. Over the past 50 years, global supply-side shocks have triggered cost-push inflation, which was often accommodated by expansionary policies. This paper analyses the historical trajectory of inflationary shocks in Greece, aiming to document inflation trends from the early 1970s to the present. In particular, it identifies the underlying forces that have driven inflation, which in turn entails an examination of both domestic demand and supply shocks, as well as global supply shocks. We find that there is a direct interplay between domestic demand and supply shocks, global supply shocks driven by geopolitical tensions and Greek headline inflation.

Keywords: Greece; inflation; geopolitical risks; demand shocks; supply shocks

JEL classification: C1; E3; F5

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ΠΛΗΘΩΡΙΣΤΙΚΕΣ ΔΙΑΤΑΡΑΧΕΣ ΣΤΗΝ ΕΛΛΑΔΑ: ΠΡΟΣΔΙΟΡΙΣΤΙΚΟΙ ΠΑΡΑΓΟΝΤΕΣ ΚΑΙ ΕΠΙΠΤΩΣΕΙΣ

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ΠΕΡΙΛΗΨΗ

Οι παγκόσμιες γεωπολιτικές εντάσεις έχουν αυξηθεί σημαντικά τα τελευταία χρόνια. Αυτό επηρέασε τις οικονομίες κυρίως μέσω των τιμών των εμπορευμάτων. Ως αποτέλεσμα, στον απόηχο των γεωπολιτικών κρίσεων, ο παγκόσμιος πληθωρισμός έχει αυξηθεί σημαντικά. Δεδομένης της μεγαλύτερης συμμετοχής των τιμών της ενέργειας και των τροφίμων στον εγχώριο δείκτη τιμών καταναλωτή, ο πληθωρισμός στην Ελλάδα αυξήθηκε επίσης. Με βάση τα ιστορικά στοιχεία, η ελληνική οικονομία έχει επανειλημμένα βιώσει περιόδους υψηλού και επίμονου πληθωρισμού. Τα τελευταία 50 χρόνια οι παγκόσμιες κρίσεις από την πλευρά της συνολικής προσφοράς προϊόντος προκάλεσαν επιτάχυνση του πληθωρισμού κόστους στην Ελλάδα. Εξαιτίας μάλιστα των επεκτατικών οικονομικών πολιτικών, οι οποίες διευκόλυναν την ενίσχυση των εγχώριων πληθωριστικών πιέσεων, ο πληθωρισμός κόστους συχνά εξελισσόταν σε έναν επίμονο πληθωρισμό ζήτησης. Η παρούσα μελέτη αναλύει την ιστορική διαδρομή των πληθωριστικών διαταραχών στην Ελλάδα από τις αρχές της δεκαετίας του 1970 μέχρι σήμερα με στόχο την ανίχνευση των κύριων προσδιοριστικών παραγόντων. Ειδικότερα, εξετάζει την επίδραση των διαταραχών, εγχώριων και εξωγενών, από την πλευρά τόσο της συνολικής προσφοράς προϊόντος όσο και της συνολικής ζήτησης. Τα εμπειρικά ευρήματα διαπιστώνουν την ύπαρξη άμεσης αλληλεπίδρασης μεταξύ των διαταραχών στην εγχώρια ζήτηση και προσφορά, του αυξημένου γεωπολιτικού κινδύνου και του εγχώριου πληθωρισμού.

ΜΗ ΤΕΧΝΙΚΗ ΣΥΝΟΨΗ

Οι παγκόσμιες γεωπολιτικές εντάσεις έχουν αυξηθεί σημαντικά τα τελευταία χρόνια. Αυτό επηρέασε τις οικονομίες κυρίως μέσω των τιμών των εμπορευμάτων. Ως αποτέλεσμα, στον απόηχο των γεωπολιτικών κρίσεων, ο παγκόσμιος πληθωρισμός έχει αυξηθεί σημαντικά. Δεδομένης της μεγαλύτερης συμμετοχής των τιμών της ενέργειας και των τροφίμων στον εγχώριο δείκτη τιμών καταναλωτή, ο πληθωρισμός στην Ελλάδα επίσης αυξήθηκε. Με βάση τα ιστορικά στοιχεία, η ελληνική οικονομία έχει επανειλημμένα βιώσει περιόδους υψηλού και επίμονου πληθωρισμού. Τα τελευταία 50 χρόνια οι παγκόσμιες κρίσεις από την πλευρά της συνολικής προσφοράς προϊόντος προκάλεσαν επιτάχυνση του πληθωρισμού κόστους στην Ελλάδα. Εξαιτίας μάλιστα των επεκτατικών οικονομικών πολιτικών, οι οποίες διευκόλυναν την ενίσχυση των εγχώριων πληθωριστικών πιέσεων, ο πληθωρισμός κόστους συχνά εξελισσόταν σε έναν επίμονο πληθωρισμό ζήτησης.

Η παρούσα μελέτη αναλύει την ιστορική διαδρομή των πληθωριστικών διαταραχών στην Ελλάδα από τις αρχές της δεκαετίας του 1970 μέχρι σήμερα με στόχο την ανίχνευση των κύριων προσδιοριστικών παραγόντων. Τα κύρια ερωτήματα στα οποία επιδιώκει να απαντήσει είναι τα εξής: Τι σημαίνει ο όρος "διαταραχή" για τη λειτουργία της οικονομίας; Από ποια χαρακτηριστικά καθορίζεται η πληθωριστική διαταραχή; Πώς επηρεάζουν τον πληθωρισμό παγκόσμια και εγχώρια γεγονότα; Ποιο ήταν το ιστορικό πλαίσιο του πληθωρισμού στην Ελλάδα και ποιοι οι προσδιοριστικοί παράγοντες; Ειδικότερα, εξετάζει την επίδραση των διαταραχών, εγχώριων και εξωγενών, από την πλευρά τόσο της συνολικής προσφοράς προϊόντος όσο και της συνολικής ζήτησης. Εστιάζοντας το ενδιαφέρον στις παγκόσμιες γεωπολιτικές εντάσεις, οι οποίες κατά κανόνα θεωρούνται εξωγενείς διαταραχές, αναλύει την επίπτωση μιας αύξησης του γεωπολιτικού κινδύνου στον εγχώριο πληθωρισμό και στο ρυθμό οικονομικής μεγέθυνσης με τη χρήση ενός διαρθρωτικού αυτοπαλίνδρομου σχήματος. Ο γεωπολιτικός κίνδυνος προσεγγίζεται ποσοτικά με το δείκτη GPR (Geopolitical Risk Index) των Caldara and Iacoviello (2022). Εξετάζεται επίσης η επίδραση από μια αύξηση της οικονομικής και πολιτικής αβεβαιότητας οφειλόμενη σε τοπικούς, ιδιοσυγκρασιακούς παράγοντες, η οποία προσεγγίζεται ποσοτικά με το δείκτη WUI-Greece (World Uncertainty Index-Greece) των Ahir et al. (2022).

Τα εμπειρικά ευρήματα διαπιστώνουν την ύπαρξη άμεσης αλληλεπίδρασης μεταξύ των διαταραχών στην εγχώρια ζήτηση και προσφορά, του αυξημένου γεωπολιτικού κινδύνου και του εγχώριου πληθωρισμού. Ειδικότερα, η μελέτη για την περίπτωση της Ελλάδας καταδεικνύει ότι η αβεβαιότητα που προκύπτει τόσο από εγχώρια γεγονότα όσο και από παγκόσμιες γεωπολιτικές εντάσεις ασκεί σημαντική επιρροή στον εγχώριο πληθωρισμό. Με την επέλευση ενός παγκόσμιου γεωπολιτικού γεγονότος, ο αντίκτυπος στον εγχώριο πληθωρισμό είναι μεγαλύτερος και έχει μεγαλύτερη διάρκεια σε σχέση με την εμφάνιση ενός τοπικού γεγονότος, υπό την προϋπόθεση, όμως, ότι η νομισματική πολιτική αντιδρά με στόχο τον περιορισμό των πληθωριστικών πιέσεων. Τα ευρήματα υποδηλώνουν επίσης ότι οι διαταραχές που οφείλονται στην εγχώρια ζήτηση συνεπάγονται πιο επίμονες πληθωριστικές πιέσεις σε σύγκριση με εκείνες που προκαλούνται από διαταραχές στην εγχώρια προσφορά προϊόντος.

THE LONG RECORD OF INFLATION SHOCKS IN GREECE: DRIVERS AND IMPACTS*

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1 INTRODUCTION

From mid-2021 to mid-2022, global inflation surged due to a demand shock driven by pent-up consumer activity following the post-pandemic economic reopening. The fiscal measures implemented during the pandemic further increased demand for goods and services, exceeding the economy's productive capacity and destabilising private inflation expectations (Dynan and Elmendorf 2024). At the same time, global supply shocks, triggered by major geopolitical events, further compounded the impact of the initial demand shock on inflation (Seiler 2022).

Past record has shown that higher energy prices and disruptions to global supply chains consistently contributed to inflation pressures. The question of whether post-pandemic inflation was primarily driven by demand or supply shocks has been the subject of debate among both academic researchers and policy makers over recent years (Ha et al. 2022; Vorisek et al. 2022; Bernanke and Blanchard 2024). This debate has also prompted a resurgence of interest in the experience of the global economy during the period of Great Inflation in the 1970s, with a particular focus on elucidating the contribution of demand and supply shocks to the underlying causes of the inflationary process (see, inter alia, Nelson 2022 and Caldara et al. 2024). This debate is critically important for setting monetary policy. It has been argued that monetary policy should respond forcefully enough to demand-driven shocks arising from large fiscal programmes that put sustained upward pressure on inflation (Blanchard 2021; Summers 2021) and have a less forceful response to supply shocks, as inflation driven by supply shocks is likely to reverse relatively quickly (Forbes et al. 2024; Reifschneider and Wilcox 2022).

Central to this debate are questions about the transitory versus permanent nature of inflation, the origin of shocks (demand-driven versus supply-driven shocks) and the appropriate roles of fiscal and monetary policy in mitigating inflationary pressures. Bernanke and Blanchard (2024) posit that the post-pandemic inflation surge in eleven advanced economies was predominantly precipitated by energy and food price fluctuations. The absence of a substantial degree of wage indexation, coupled with the prevalence of anchoring, effectively precluded the emergence of a price-wage spiral, thereby averting the escalation of inflation to a persistent state. On the other hand, Giannone and Primiceri (2024) argue that domestic demand shocks were the most important drivers of the post-pandemic inflation.

This paper analyses the historical trajectory of inflationary shocks in Greece, aiming to document inflation trends from the early 1970s to the present. In particular, it identifies the underlying forces that have driven inflation, which in turn entails an examination of both domestic demand and supply shocks, as well as global supply shocks, and an analysis of their respective effects. As is evident from the historical data, Greece has repeatedly experienced periods of inflationary pressure. Over the past 50 years, global supply-driven shocks have triggered cost-push inflation, which was often accommodated by expansionary fiscal and monetary policies. This policy response transformed temporary supply shocks into per-

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sistent demand-pull inflation, resulting in significant output losses.[1]

The principal questions that this study seeks to address are as follows: what is meant by the term "shock" in the context of economics; what characteristics define an inflation shock; how do global and domestic shocks affect inflation; what was the historical context of inflation in Greece; and what factors have driven inflation in Greece. We find that there is a direct interplay between domestic demand and supply shocks, global supply shocks and Greek headline inflation. The evidence suggests that global geopolitical shocks and inflation have had a substantial impact. It is equally evident that domestic demand shocks have played a significant role in determining domestic inflation. These domestic demand shocks, originating from the fiscal and monetary accommodation of global supply shocks, have turned cost-push inflation into demand-pull inflation with high persistence. However, it is also evident that domestic supply shocks have also played a significant role.

The rest of the paper is organised as follows. Section 2 presents a simple definition of a shock in economics and especially of an inflation shock. It distinguishes between global and domestic shocks and discusses whether there is a link between global geopolitical shocks and inflation. Section 3 offers an overview of Greece's inflationary trends, emphasising the interplay between demand- and supply-driven shocks. Section 4 presents the empirical methodology employed to quantify the impact of shocks on inflation and reports the empirical findings. Section 5 concludes. An appendix at the end of the paper presents the definitions of the variables and the data sources used in the analysis.

2 INFLATION SHOCKS

In the field of economics, a "shock" is defined as a significant event, whether positive or negative, that is both unexpected and unpredictable and often originates from outside the economy. It is an unpredictable change in exogenous factors, which are unexplained by an economic model and may influence endogenous economic variables. Such an event has the potential to disrupt the normal functioning of the economy, leading to major changes within it. Shocks are divided into global and domestic ones. Global shocks are largely exogenously-driven events. They encompass shocks to aggregate supply, aggregate demand,[2] commodity prices (e.g. energy and food) and financial shocks, including a stock market crash, a liquidity crisis in the banking system, unpredictable changes in monetary policy or an international currency devaluation. Domestic shocks are endogenously-driven local events. They include shocks to domestic supply and demand as well as monetary policy surprises in response to domestic demand developments. Thereby, global negative supply shocks or domestic positive demand shocks are important sources of an inflation shock.

2.1 DEMAND- VERSUS SUPPLY-DRIVEN SHOCKS

An inflation shock is an unexpected or unpredictable sharp rise in inflation that has an unforeseeable large-scale impact on the economy. This is the well-known case of what is called "the Great Inflation Era" in the 1970s, a period of very high global inflation between 1973 and 1982.

Inflation shocks can be categorised as either demand- or supply-side shocks.[3] On the demand side, many factors, including monetary and fiscal policy, affect aggregate demand and, thus, inflation. On the supply side, in the long run, productivity growth determines aggregate supply and inflation. However, in the short run, abrupt and largely exogenously-driven events,

1 For the impact of the monetary accommodation regime on inflation in the years leading up to the introduction of the euro, see Lazaretou (2024).
2 Global supply shocks are intrinsically linked to global supply chains and commodity prices, including oil prices. They affect producer prices. Global demand shocks refer to an unpredicted and exogenous change in global demand for a product or service, ordinarily temporary in nature, and typically generated by a global pandemic or natural disaster.
3 For a discussion on demand and supply shocks, see Blinder and Rudd (2013).

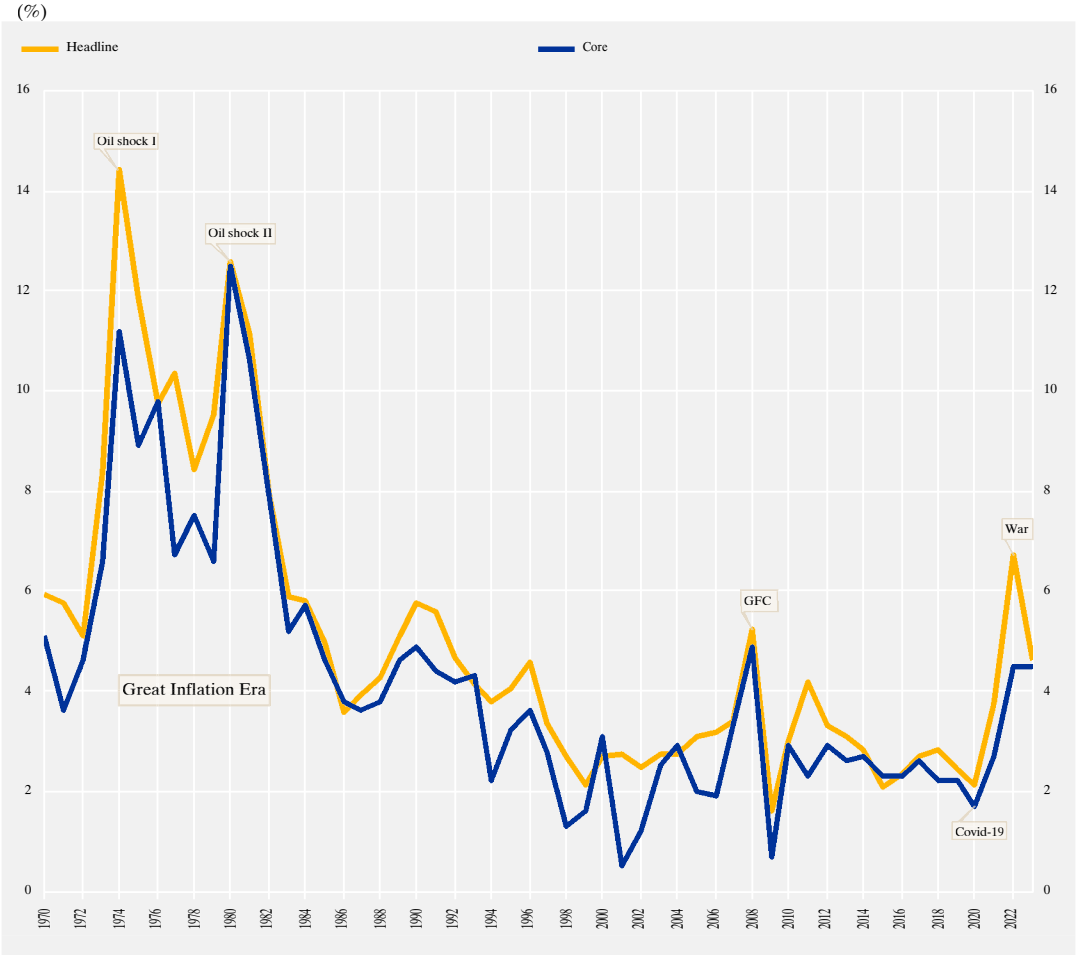
such as market or trade restrictions, supply chain disruptions due to natural disasters, pandemics, etc., major geopolitical tensions or even nominal rigidities, such as wage-price controls, can occasionally affect aggregate supply and push headline inflation above core inflation. For example, we refer to rapid increases in food and/or energy prices, which require rapid adjustments in relative prices.

At any given moment, there is a core (underlying) inflation rate toward which the headline (actual) rate tends to converge. This "equilibrium" rate is determined by the fundamentals of aggregate demand and supply. Thereby, headline inflation can markedly deviate from core inflation over short periods of time, signalling an inflation shock. Furthermore, if core inflation becomes more sensitive to increases in headline inflation, then inflation persists (Ha et al. 2019; Vorisek et al. 2022). In this case, monetary policy shocks play a crucial role, in the sense that monetary policy either accommodates the initial inflation shock and aggravates the impacts or forcefully responds to and mitigates the initial impact of an inflation shock.

2.2 GLOBAL SHOCKS AND GLOBAL INFLATION: IS THERE A LINK?

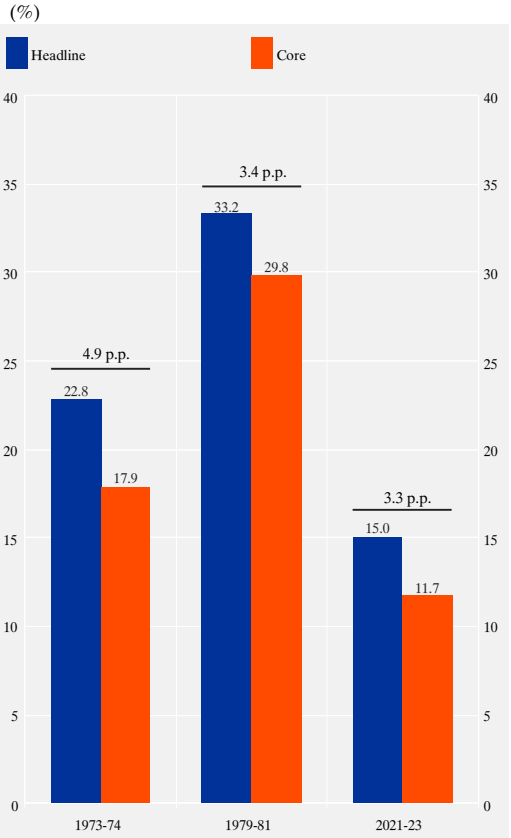
As seen in Chart 1, which plots global headline and core inflation over the past 50 years, global

Chart 1 Global inflation shocks (1970-2023)



Source: Ha et al. (2023), April 2024 update.
Notes: Headline (HCPI) and core global inflation rate, GDP-weighted average, annual averages.

Chart 2 Growing global core inflation sensitivity to an initial inflation shock



Source: Ha et al. (2023), April 2024 update.
Note: Authors' estimations: cumulative global inflation rate.

shocks reflect a continuation of a long-term trend of inflation shocks. They, thus, played a prominent role in explaining variations in global inflation on average. Explicitly, negative economic shocks may be attributed to government interventions, alongside rises in production costs. Such costs may be attributed to a number of factors, including geopolitical confrontations, pandemics, commodity price fluctuations and supply chain disruptions. These factors have been shown to increase inflation. Inflation is perceived by economic agents as a negative phenomenon, which is rarely interpreted and alters their behaviour and their decision-making process (see Binetti et al. 2024).

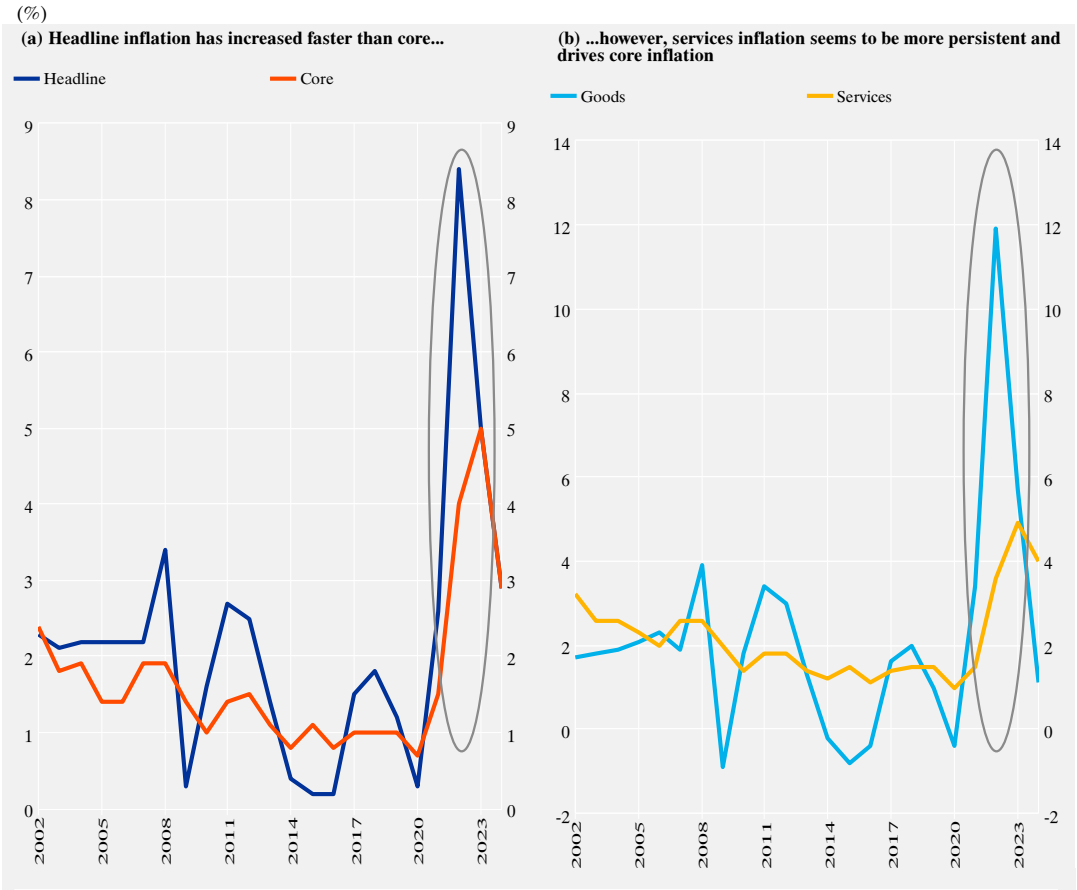
It is important to note that global shocks do not necessarily imply global supply shocks. Indeed, they frequently encompass supply shocks, as evidenced by the two oil price shocks that occurred in the 1970s and, more recently, the global pandemic of 2020-21 and the outbreak of the Russia-Ukraine war in 2022. Conversely, global demand shocks have been observed to be accommodated by loose monetary policy and inflation surprises. Examples of such demand shocks include the rise in inflation before the global financial crisis of 2007-08 and the inflation surge that occurred with the reopening of the economy after the lockdowns in the second half of 2021.

The key question is whether there is a pass-through of headline inflation to core inflation, which, if confirmed, would indicate a state of persistent inflation. As seen in Chart 2, during the 1973-74 inflation shock, the discrepancy between headline and core inflation was 5 percentage points (pps). This discrepancy was significantly smaller in subsequent inflation shocks, indicating that core inflation was becoming more sensitive to a shock in headline inflation. Concerning the euro area (see Chart 3), headline inflation increased faster than core during the more recent shock in 2021-23, signalling that inflation expectations were well anchored at least during the first phase of the global inflation shock, mostly attributed to the pandemic. Then, however, core inflation caught up with headline inflation (see Chart 3, panel a), as services inflation trended higher, while goods inflation substantially eased (see Chart 3, panel b), demonstrating that the demand shock drove core inflation over the past two years. More importantly, this development signals that structural factors in different sectors seem to drive price setting and, therefore, further monetary policy rate increases might lead to an economic slack.

2.3 GEOPOLITICAL SHOCKS AND INFLATION

Geopolitical shocks are considered a prime example of global supply shocks. They are defined as a dramatic and unanticipated event of violence, such as war conflicts, terrorist attacks and trade disputes, that results in supply chain

Chart 3 The 2022-24 inflation shock in the euro area (2002-2024)



Source: Eurostat.
Note: HICP, annual average rate of change.

disruptions and regulatory changes. These events are purely exogenously driven and largely unanticipated negative shocks that cause geopolitical uncertainty, which is distinct from other types of uncertainty, economic or political, often driven by economic or political considerations.

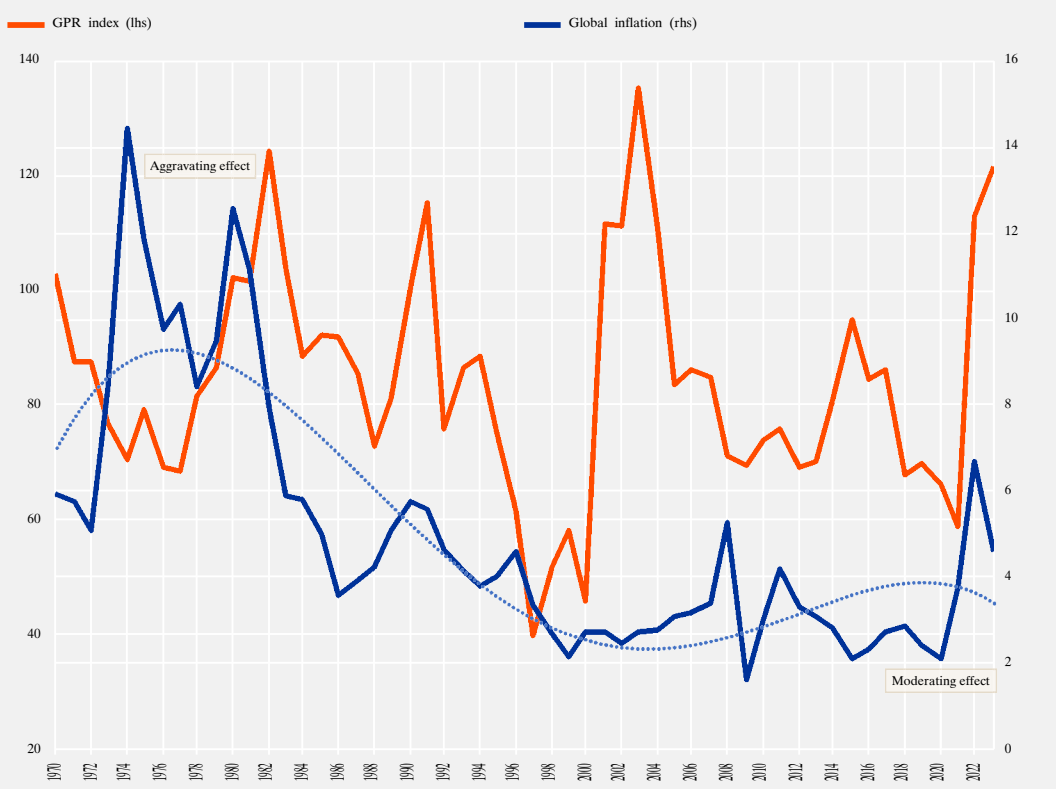
The empirical literature on the link between geopolitical uncertainty and the economy has been growing recently.[4] See, for example, Feng et al. (2023) on the negative impact of geopolitical uncertainty on capital flows, Wang et al. (2024) on corporate investment, Salisu et al. (2022) on stock market returns, Caldara and Iacoviello (2022) on real GDP growth rate and Kapopoulos et al. (2024) on foreign direct investment. Two factors have contributed to the recently increased research interest. First, the latest geopolitical tensions have led to renewed concern about the risks for economic activity. Second, the new metric of geopolitical risk, namely the global Geopolitical Risk (GPR) Index, recently constructed by Caldara and Iacoviello (2022), allows the possibility to quantify the impact of geopolitical tensions on the economy.

According to Caldara and Iacoviello (2022, p. 1197), geopolitical risk is defined as "...the threat, realization, and escalation of adverse events associated with wars, terrorism, and any tensions among states and political actors that affect the peaceful course of international rela-

4 The literature, both theoretical and empirical, on how shocks originated by economic policy shifts or political changes impact economic agents' behaviour, thus affecting financial and economic variables, is well featured. See Bernanke (1983), Rodrick (1991), Bloom (2009) and Bloom et al. (2018).

Chart 4.1 Do GPR and inflation move together? (1970-2023)

(lhs: index 1900-2019=100; rhs: annual percentage changes)



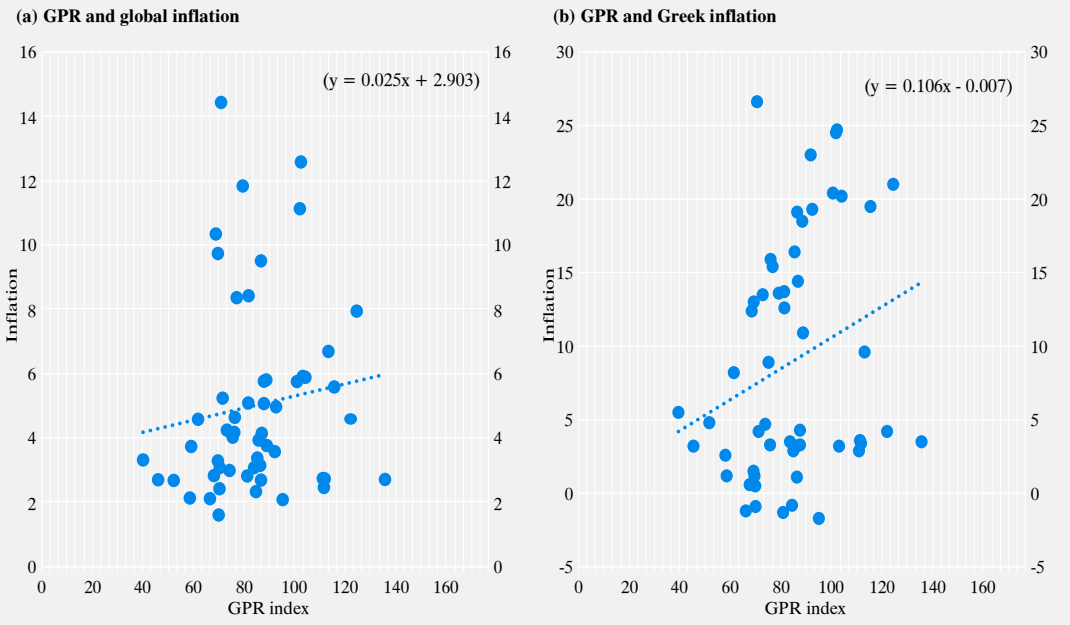
Sources: Ha et al. (2023), April 2024 update; Caldara and Iacoviello (2022), https://www.matteoiacoviello.com/gpr.htm.
Notes: GPR= global geopolitical risk index; headline CPI inflation. The blue dotted line depicts the time trend of headline CPI.

tions". In other words, geopolitical motives are viewed as situations in which the power struggles of agents over territories cannot be resolved peacefully and democratically. They constructed the GPR Index by counting the number of "risk" words in 10 leading English language newspapers' articles discussing global geopolitical events through an automated text search in the electronic archives of these newspapers. The index is the ratio of the total number of articles related to adverse geopolitical events in each newspaper for each month, divided by the total number of published articles. By construction, the GPR Index captures the risks that both threats and acts of violence materialise.[5]

In this context, we seek to examine the association between geopolitical risks and inflation. The central question guiding this inquiry is whether geopolitical shocks, defined as global supply shocks, and inflation move together. It is evident that geopolitical factors have played a significant role in the occurrence of major global inflationary pressures. As seen in Chart 4.1, which plots the GPR Index and global headline inflation, geopolitics is a common thread that runs through the three major global inflation shocks, namely the 1973-74 OPEC I shock, the 1979-80 OPEC II shock and the 2021-2023 inflation episode. Cases of a positive correlation are evidenced at the global level (see Chart 4.2, panel a) and even more so at the country level (see Chart 4.2, panel b), with Greece serving as an example.

5 These risks are the result of eight categories of external events: war threats, peace threats, military build-ups, nuclear threats, terror threats, beginning of war, escalation of war, terror acts. See https://www.matteoiacoviello.com/gpr.htm.

Chart 4.2 Is there a positive correlation between the geopolitical risk index and inflation?



Sources: Ha et al. (2023), April 2024 update; Caldara and Iacoviello (2022), https://www.matteoiacoviello.com/gpr.htm.
Notes: GPR= global geopolitical risk index; headline CPI inflation.

This simple stylised fact gives rise to a number of valuable insights. Global geopolitical shocks tend to be negative supply shocks and, thus, important drivers of cost-push inflation. In the case of monetary policy accommodation of the initial shock, cost-push inflation might end up as demand-pull inflation (aggravating effect). This was precisely the case with the surprise in global inflation well before the outbreak of the OPEC II shock, when major central banks transitioned to a loose monetary policy, thereby exacerbating the initial impact of the global supply shock on inflation (see DeLong 1997 and Orphanides 2003). On the contrary, a more responsive reaction of central banks mitigates the initial impact (moderating effect). This was exemplified by the recent episode of inflation, during which central banks adopted a policy of forceful money tightening.

Specifically, in the case of an inflation targeting regime, the response of monetary policy authorities usually depends on whether the shock is temporary or long-lasting, so as to avoid the de-anchoring of long-run inflation expectations. This can be achieved by utilising the favourable trade-off that widespread supply bottlenecks present to central banks when confronted with a demand shock. In such a scenario, the short-run Phillips curve is observed to be steeper and shift upwards, signifying that monetary tightening can be effective in curbing inflation while minimising output loss. It can be concluded that policy tightening exerts a significant effect on inflation, whilst exerting a comparatively smaller effect on economic output. This is precisely the case with the ECB's attempt to curb inflation during the recent inflation shock. However, when headline inflation is embedded in core inflation and spikes in certain sectors (e.g. services), policy tightening is not appropriate for controlling inflation anymore, since these spikes produce shifts in relative prices and resource misallocation, while interest rate rises produce output contraction (Bandera et al. 2023; Tenreyro 2023). In order to effectively address core inflation, it is essential to gain a comprehensive understanding of the structural factors that influence price setting across various sectors.

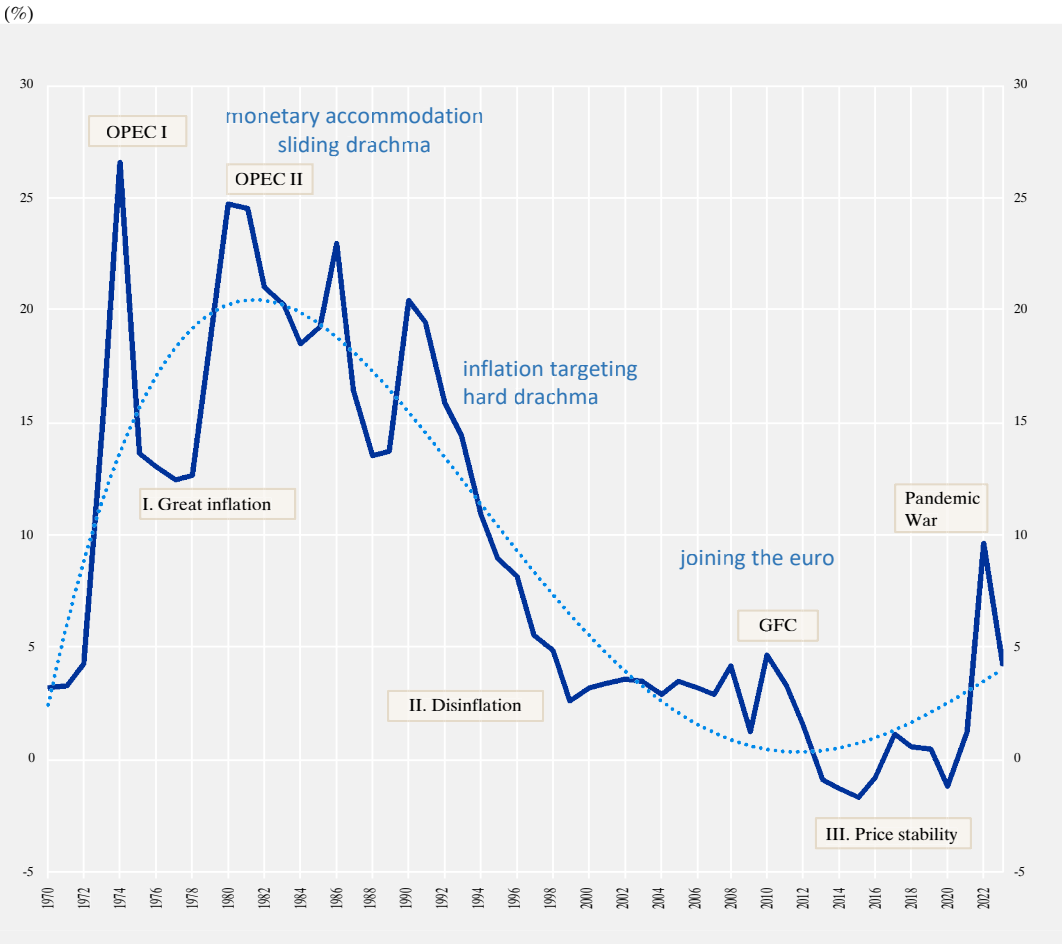
Therefore, the implementation of structural reforms is a more suitable approach to mitigating inflation persistence.

3 AN OVERVIEW OF INFLATION IN GREECE

3.1 A SNAPSHOT

Over the past 50 years, Greece has experienced three distinct phases of inflation, which have been linked not only to global supply shocks, but also to repeated domestic demand shocks. As demonstrated in Chart 5, the initial phase from the early 1970s until the early 1990s witnessed remarkably high and excessively volatile inflation. The two major global supply shocks in the 1970s as well as repeated domestic demand shocks were the primary drivers of inflation during that period. Global supply shocks were precipitated by two oil price shocks, which, in turn, were caused by two major geopolitical shocks of that time. Concurrently, domestic demand shocks emanated from the fiscal and monetary accommodation regime of the 1980s. The second phase began in 1995 and was marked by disinflation. That year, an inflation-targeting regime was introduced under which the exchange rate was used as a nominal anchor. The third phase began with the country's adoption of the euro and the submission of the domestic economy to a sin-

Chart 5 Three distinct phases of the inflation process in Greece



Source: Ha et al. (2023), April 2025 update.
Notes: Headline CPI inflation. The blue dotted line depicts the time trend of HCPI.

gle monetary policy, and was defined by low and stable inflation.

In the light of the above, we highlight two key facts. During the first phase of inflation, in addition to the global supply shocks of the 1970s, domestic monetary surprises in the 1980s also played an important role in determining domestic inflation. On the contrary, the process of inflation during the second and the third phases can be seen as an application in the Greek monetary policy of the Barro-Gordon model and the implied credibility hypothesis, according to which, when monetary policy is credible, private agents adjust their inflation expectations accordingly and, therefore, inflation actually falls with a limited loss of output.

3.2 COUNTRY-SPECIFIC SHOCKS, UNCERTAINTY AND INFLATION

The above inflation snapshot gives rise to the question how shocks drove inflation in Greece. Chart 6, panel (a) plots both headline inflation and an index of uncertainty for Greece, namely the World Uncertainty Index (WUI-Greece), which has been constructed by Ahir et al. (2022) by counting the frequency of the word "uncertainty" and its variants in the country reports for Greece of the Economist Intelligence Unit. The index is designed to identify potential risks to the Greek economy. In the absence of a country-specific geopolitical risk index, the WUI-Greece is used as a proxy for a country-specific metric with the objective of capturing the uncertainty generated by both global and idiosyncratic events. It assesses the impact of shocks arising from geopolitical, economic and political events. Despite its global focus, it is more domestic in nature and gives greater weight to domestic economic developments, political shifts or instability as well as to challenges that may be related to both global and regional developments.[6]

It can be shown that both variables exhibit a reciprocal relationship. Prior to 2002, a positive correlation was observed between headline inflation and uncertainty (see Chart 6, panel b). Conversely, after 2002, despite repeated increases in uncertainty, a negative correlation was observed, thereby suggesting that the adherence to an inflation-targeting single monetary policy, which helped to anchor long-term inflation expectations, mitigated the adverse effect of a shock, either global or domestic in nature, on inflation (see Chart 6, panel c).

4 EMPIRICAL ANALYSIS

To assess the impact of uncertainty on inflation and real output, we employ a structural modification of a Bayesian vector autoregressive (VAR) model based on quarterly Greek data from 2000Q1-2024Q2.[7] The chosen period covers three milestones impacting the domestic economy: Greece's entry into the EMU in 2001, the 2010 sovereign debt crisis and the subsequent economic crisis, the pandemic and the impact of the war in Ukraine.

The general specification is as follows:

$$Y_t = A_0 + \sum_{i=1}^{p} A_i Y_{t-i} + B_j X_t + e_t \qquad (1)$$

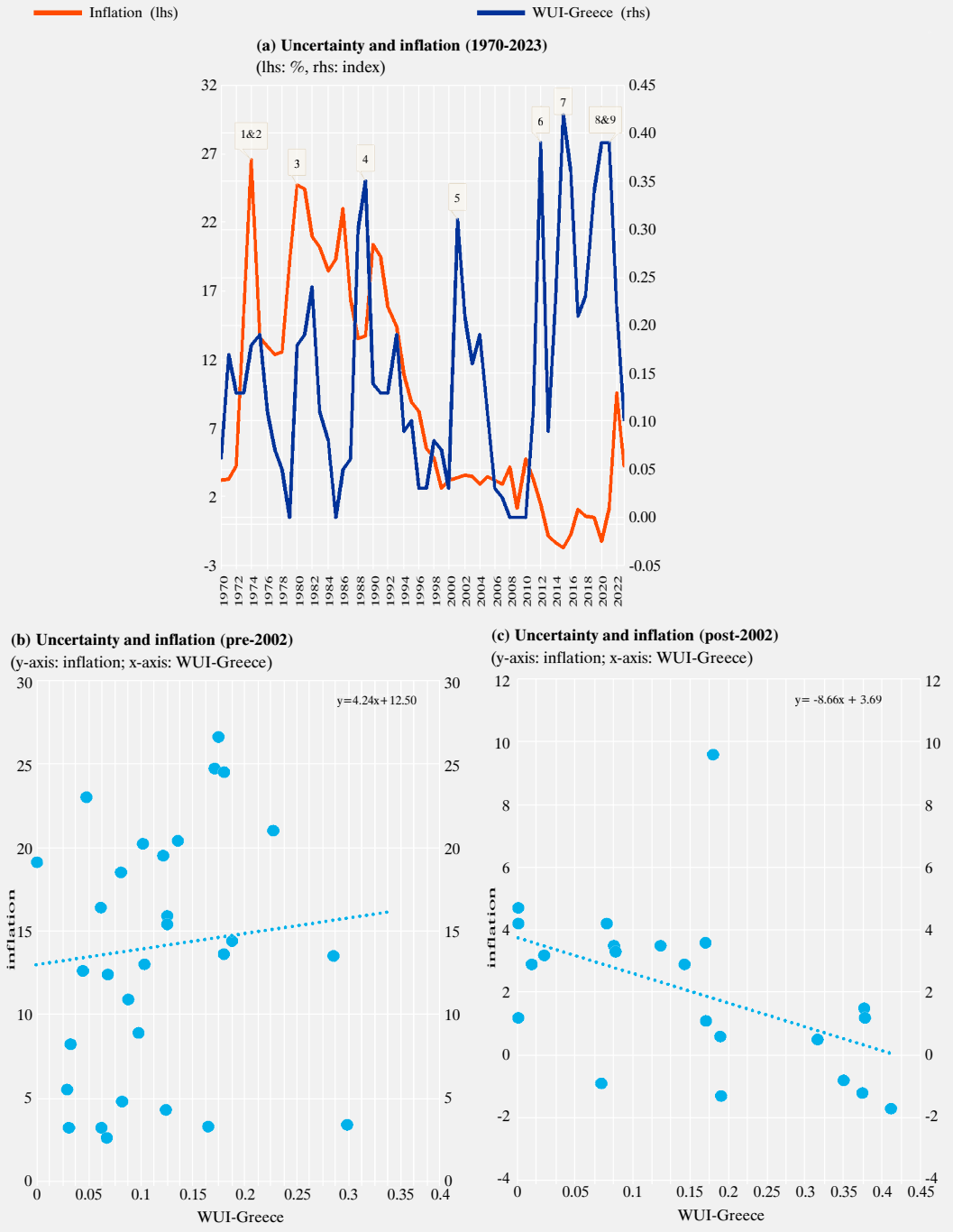
where Y_t denotes a standard structural vector of endogenous variables of our BVAR[8] model and p denotes the lag structure, with a total of four lags being utilised in the analysis, given the quarterly frequency of the data series. We assume $Y_t=(cop_t\ \pi_t\ y_t\ r_t)$ where cop_t denotes the annualised growth rate of the Brent oil price, π_t denotes the quarterly average of HICP inflation (y-o-y), y_t is the annualised quarterly real growth

6 For example, at the current juncture, the heightened uncertainty stems from the ongoing trade and tariff disputes, a purely exogenous event for the Greek economy.

7 The sample period commences in 2000, rather than on an earlier date, due to the data availability for the macroeconomic time series employed in the analysis.

8 Regarding the prior distributions for our BVAR model, we follow its simplest form and employ the Minnesota prior (Litterman 1986). In this framework, it is assumed that the VAR residual variance-covariance matrix is known in terms of its signs of effects (see also the note in the table). Moreover, we use optimal hyperparameter values from a grid search that employs the criterion of Giannone et al. (2015), who propose a procedure to select the optimal hyperparameters based on the maximisation of the value of the marginal likelihood of the model. For details, see the BEAR toolbox technical guide. To construct error bands, we perform 10,000 repetitions burning out 50% of them.

Chart 6 How do shocks drive inflation in Greece?



Sources: Headline CPI Greece: Ha et al. (2023), April 2024 update; WUI-Greece: Ahir et al. (2022), April 2024 update.
Notes: Headline inflation. Major country-specific political and economic events are depicted.
1&2: 1973 Turkish invasion of Cyprus; 1974 Athens Polytechnic uprising; 3: 1981 Political change; 4: 1989 Hung parliament, threat of a sovereign default; 5: 2000-01 Athens Stock Exchange bubble; 6: 2012 Economic and political uncertainty related to sovereign debt sustainability, bank solvency and Grexit; 7: 2015 Uncertainty related to Greece's euro area membership; 8&9: 2020 Covid-19, 2022: War in Europe.
The WUI-Greece has been computed by counting the frequency of the word "uncertainty" or its variants in the Economist Intelligence Unit country reports. The index is normalised by the total number of words and rescaled by multiplying by 1000. A higher number means higher uncertainty and vice versa.

rate of the Greek economy and r_t is the quarterly average of the 3-month Euribor. The vector of endogenous variables has been selected on the basis of their extensive utilisation in the empirical literature (see, for example, Caldara et al. 2020 and 2024; Ahir et al. 2022). The matrices A_i and B_j denote the estimated coefficients.

In order to determine the extent to which supply- and/or demand-driven inflation shocks have important implications for inflation in the Greek economy, a sign restrictions identification scheme is employed. This is pursued by means of a sign restrictions version of the Bayesian VAR, following similar identification strategies proposed by Faust (1998), Canova and De Nicoló (2002), Uhlig (2005) and Baumeister and Hamilton (2015).[9]

The adopted configuration of demand- and supply-driven shocks is predicated upon an identification strategy that aligns with a conventional textbook perspective. A demand-driven shock is defined as a shift in both prices and real output (i.e. quantities) in the same direction along an upward-sloping aggregate supply curve, while a supply-driven shock is defined as a shift in prices and real output in opposite directions along a downward-sloping aggregate demand curve.[10]

This identification scheme is utilised to differentiate between demand- and supply-driven shocks to inflation and real output growth. Supply-driven shocks may be attributed to several factors, including natural disasters such as floods or earthquakes; global supply chain disruptions primarily due to geopolitical confrontations; and changes in spending preferences, which have been impacted by the pandemic.

Concurrently, in the aftermath of the pandemic-induced lockdowns, instances of endogenously- or locally-induced demand-side shocks have been observed, including pent-up demand and increased savings that ensued from either an expansionary fiscal policy or the pandemic, ultimately resulting in elevated price inflation. Utilising the sign restrictions identification strategy in a Structural Vector Autoregression (SVAR) framework, we effectively capture the effects of supply- and demand-driven shocks to inflation. In this regard, we formulate the former as a cost-push shock, hypothesising its impact on both inflation and real output.

To better capture the effects of an external supply-side shock, we impose block exogeneity[11] to switch-off feedback loops between domestic endogenous variables π_t, y_t and cop_t assuming price determination of crude oil prices at the global level. This assumption aims to capture the relatively small size of the Greek economy compared to other economies that directly affect global supply shocks (e.g. China, US, etc.).

In order to better understand the dynamics of Greece's recent inflation experience, the model has been expanded with a set of exogenous variables represented by vector X_t, which includes the World Uncertainty Index for Greece (WUI-Greece) and the global Geopolitical Risk (GPR) Index. The incorporation of these variables into the model and their treatment as exogenous influences is aimed at better addressing inflation dynamics in the context of uncertainty stemming from both global and unanticipated country-specific events. The GPR Index is the key interest variable in this study, as it captures the impact of uncertainty resulting from geopolitical events, which are purely exogenously driven. The WUI-Greece is also treated as an exogenous variable, albeit weak, in an attempt to capture

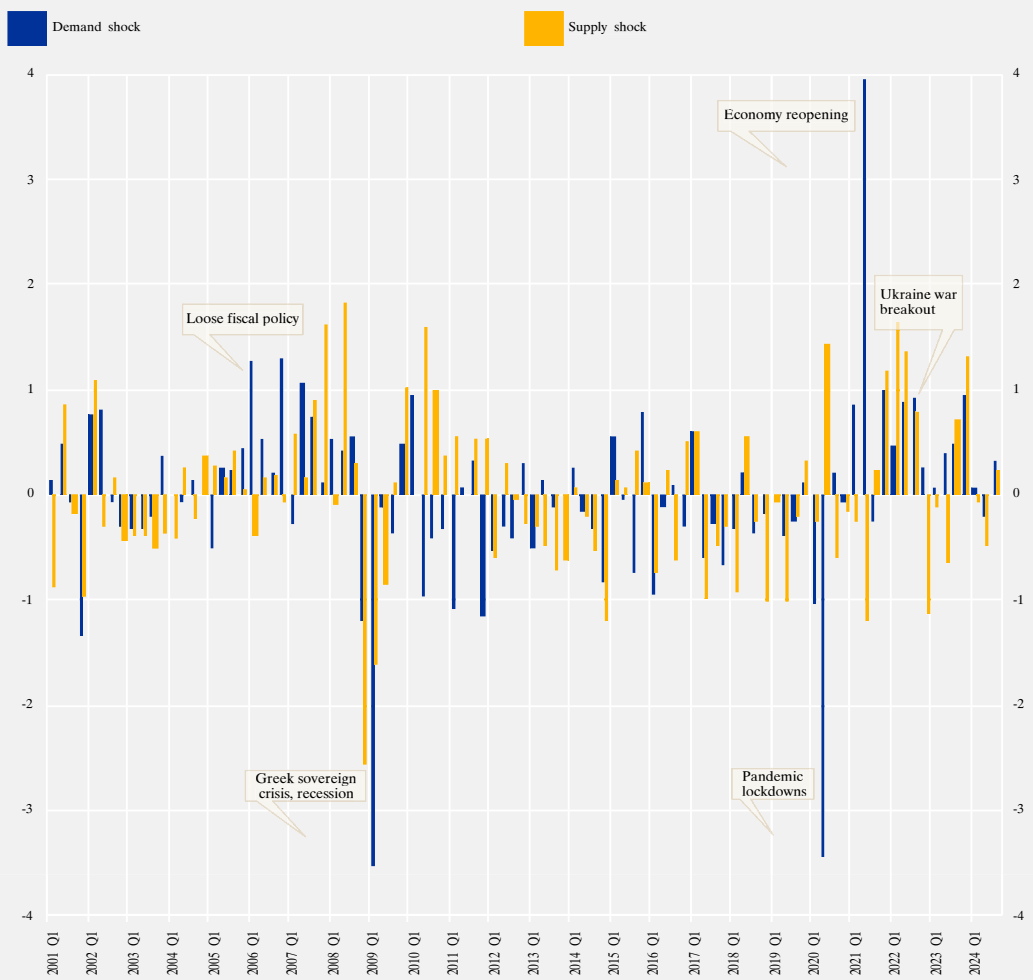
9 Other influential contributions on sign restrictions applications refer to: (i) Mountford (2005), who imposes sign restrictions in a Structural VAR model to assess the response of macroeconomic variables to monetary shocks; (ii) Mountford and Uhlig (2009), who similarly apply sign restrictions in a Structural VAR framework to analyse the effects of fiscal policy shocks on macroeconomic variables; and (iii) Arias et al. (2018), who provide a rigorous econometric framework for inference in SVARs using both sign and zero restrictions, which improves identification strategies commonly used to separate demand and supply shocks.

10 Alternative approaches to capture demand and supply shocks to inflation are employed by: (i) Ball et al. (2022), who focus on the rise in core inflation as measured by the weighted median inflation rate and deviations of headline inflation from core; and (ii) Shapiro (2024), who proposes a framework to decompose inflation into supply- and demand-driven components that generate two new data series, the supply- and demand-driven contributions to personal consumption expenditures (PCE) inflation.

11 On the formation of block exogeneity and the construction of external supply shocks, see Dieppe et al. (2016).

Chart 7 Domestic demand and supply shocks: the Greek record

(median estimate)



Source: Authors' estimations, derived from the sign restrictions identification scheme of the employed VAR model.
Note: The sample period starts in 2001 due to the data availability for the control variables in the estimated model.

the impact of economic and political uncertainty stemming from country-specific or idiosyncratic events. By construction, the WUI captures uncertainty resulting not only from political events but also from economic or financial developments. Consequently, the model may be subject to an endogenous bias. Nevertheless, from a technical standpoint, the assumed sign restrictions weaken any potential endogeneity bias stemming from the WUI, as these restrictions are predicated on economic theory. Furthermore, the results of an endogeneity test indicate that the WUI can be regarded as an exogenous variable.[12] Incorporating the WUI as a weakly exogenous variable in our analysis facilitates the identification of structural shocks emanating

12 The first core explanatory variable, namely GPR, has been shown to be purely exogenous (see Wang et al. 2024; Caldara and Iacoviello 2022). This means that the GPR Index does not systematically increase during an economic and financial crisis of global scale. Nevertheless, we employ an instrumental variable approach to deal with any endogeneity bias derived from the second explanatory variable, namely the WUI-Greece. Instrumenting the WUI-Greece with exogenous election dates helps to disentangle endogeneity between inflation and uncertainty due to economic policy developments. It is found that exogenous election dates are a robust predictor and the results from an SVAR-IV using the fitted values of the WUI-Greece suggest that the impact of innovations on inflation is similar. This means that the WUI-Greece can be considered as an exogenous variable (the results are available upon request).

from the respective variable. As illustrated in Chart 6, uncertainty in Greece has been driven by both significant global geopolitical events and domestic political events.

As outlined by Baumeister and Hamilton (2015), the sign restrictions imposed in order to decouple the two types of assumed shocks are delineated in the table. The first column incorporates a supply-side inflation shock in the form of a cost-push shock that negatively affects real output, while the demand-driven inflation shock operates in the opposite direction, affecting real output positively. Considering the prevailing context of monetary policy tightening in the euro area, it is further assumed that a reactive monetary policy is in place, whereby interest rates are increased in response to both types of shock.[13]

Following the above decomposition between a domestic demand and a supply shock, the series of demand and supply inflation shocks appear to align with the historical narrative for the Greek economy during the first two decades of the century (see Chart 7). It is observed that negative domestic demand shocks, such as the sovereign crisis, the subsequent deep recession and the pandemic lockdowns, exerted downward pressures on inflation. Conversely, the reopening of the economy has been shown to exert upward pressures. Similarly, the Ukraine war led to a global supply shock and subsequent upward pressure on domestic inflation. However, it appears that this impact was not enduring, as the initial impact was mitigated by monetary tightening.

Assumed sign restrictions for demand and supply shocks

Variable/shock	Supply-side shock (cop_t)	Demand-side shock (π_t)
π_t	+	+
r_t	+	+
y_t	–	+

Note: By definition, the variance-covariance matrix in a structural VAR context is known a priori with respect to the assumed signs, either positive or negative. No assumptions are made about the size of the shocks.

4.1 EMPIRICAL FINDINGS

We first turn to the demonstration of the impulse response functions of the exogenous variables, namely, the Geopolitical Risk (GPR) Index and the World Uncertainty Index for Greece (WUI-Greece), which are hypothesised to function as global and country-specific exogenous shocks, respectively. These effects are not captured by the dynamics of our traditional sign restrictions endogenously imposed as portrayed in the table.[14]

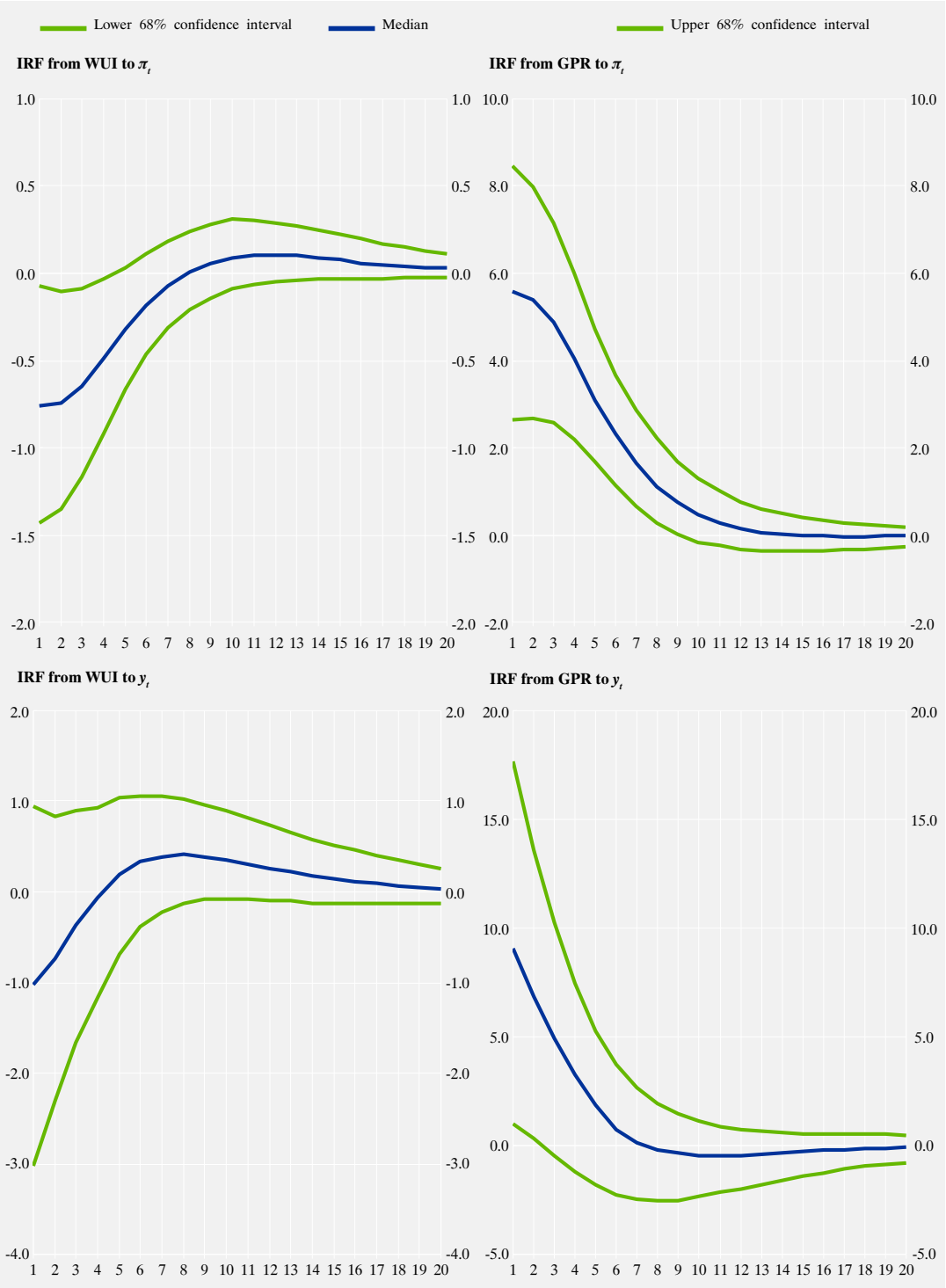
As can be seen in the context of the Greek economy, an unexpected increase (i.e. a positive shock) in the WUI-Greece stemming from a country-specific event, is estimated to have a negative effect on headline inflation in the short term (see Chart 8, top left-hand panel). Turning to the case of global geopolitical risk (GPR), the dynamic responses are opposite (see Chart 8, top right-hand panel). The estimated increase in headline inflation following a global geopolitical shock is relevant to the current rising tension. This finding is in line with previous findings in the empirical literature (see, inter alia, Caldara and Iacoviello 2022 and Caldara et al. 2024 for the global inflation; Antonnen and Lehmus 2024 for the eurozone inflation). More importantly, the estimated increase in headline inflation (at 68% confidence level) is more pronounced in comparison to the respective responses in the case of a shock in WUI. Furthermore, it is anticipated that this increase will persist for a duration of up to two years following the occurrence of the shock. This finding is consistent with the supply-side nature of the shock (see Pinchetti 2024). Furthermore, a substantial response was identified in relation to the impact of real output growth (see Chart 8, bottom right-hand panel). Multiple studies have shown a statistically significant negative correlation between

13 We make this assumption as we try to formulate a global supply shock where the ECB's monetary policy stance reacts to avoid a de-anchoring of inflation expectations.

14 In an earlier paper (Lazaretou and Palaiodimos 2023), the construction of external or global demand and supply-side shocks involved the formation of block exogeneity constraints. In this paper, we are effectively capturing these dynamics by adding the respective exogenous variables to the BVAR model.

Chart 8 Impulse response functions (IRF) in the context of uncertainty arising from country-specific and global geopolitical events to headline inflation (π_t) and real output growth rate (y_t)

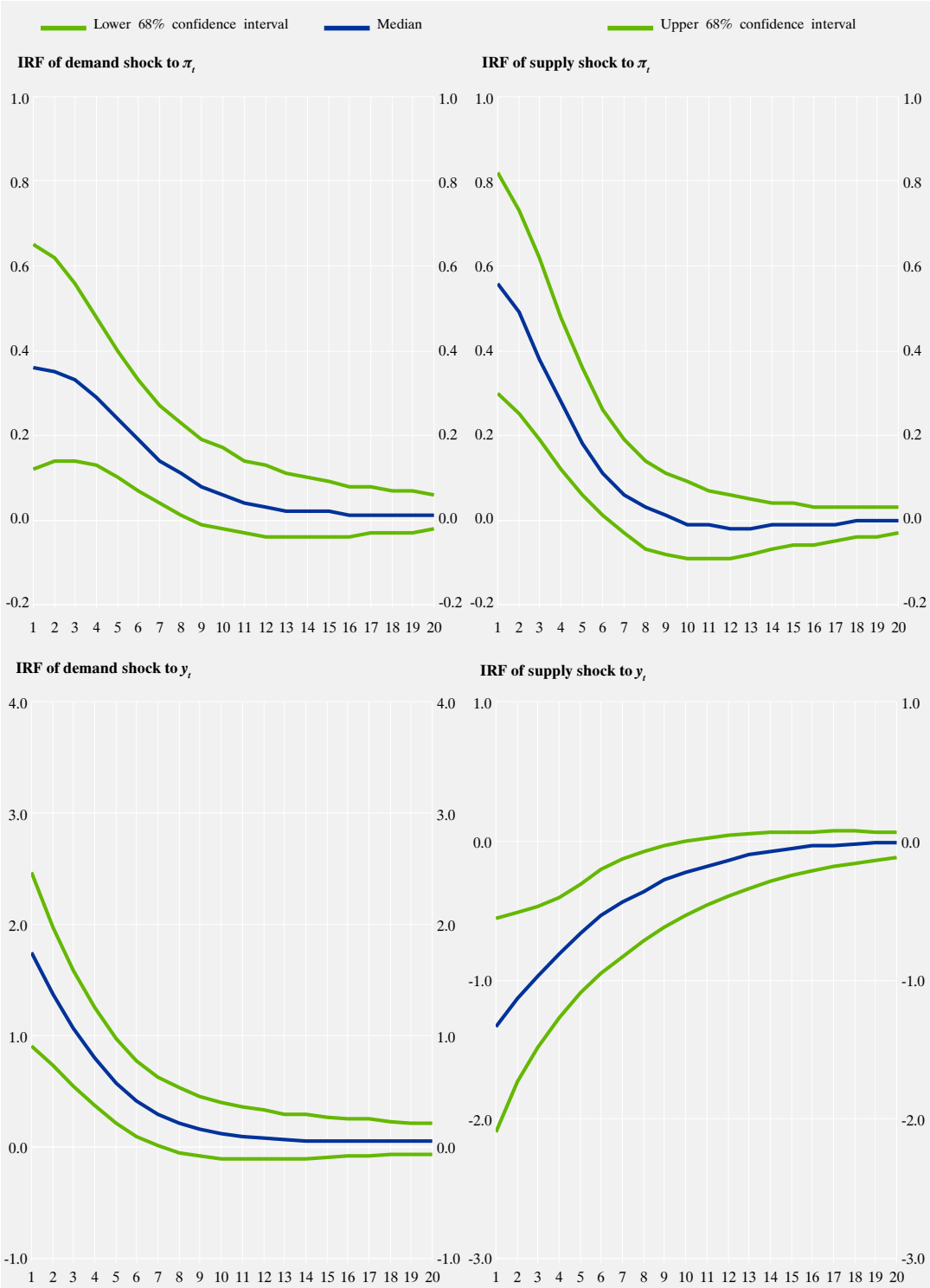
(WUI-Greece: left-hand panels; GPR index: right-hand panels)



Source: Authors' estimations.
Notes: IRF=impulse response function. Country-specific events are captured by WUI-Greece (left-hand panels). Global events are captured by the GPR index (right-hand panels). The size of the shock is equal to one standard deviation of the exogenous error process.

Chart 9 Impulse response functions from a domestic demand or supply shock to headline inflation (π_t) and real output growth rate (y_t)

(Demand shock: left-hand panels; supply shock: right-hand panels)



Source: Authors' estimations.
Note: The size of the shocks is equal to one standard deviation of the exogenous error process.

uncertainty shocks and real output (see, for example, Ahir et al. 2022 and Liu and Gao 2022 for the US; European Commission 2024 and Gieseck and Rujin 2020 for the eurozone).

In the event of a domestic demand-driven shock (e.g. a fiscal or monetary policy shock) and a domestic supply-driven shock (e.g. a natural disaster) resulting from the imposed sign restrictions outlined in the table, the findings of the impulse response function analysis are consistent with the conclusions reported in Lazaretou and Palaiodimos (2023). Specifically, domestic demand-driven shocks imply somewhat more persistent inflationary pressures compared to those produced in the case of supply-driven shocks, as seen in Chart 9 (left versus right-hand panels). These results coincide with the positive and negative implications for real output growth as imposed by the definitions of the shocks in the table.

5 CONCLUDING REMARKS

Global geopolitical tensions have increased considerably in recent years. This has affected the economies primarily via prices on commodities. As a result, global inflation has risen in the aftermath of geopolitical shocks. Given the elevated energy and food price shares in the consumer basket, Greek inflation has also risen significantly. Historically speaking, Greece has repeatedly experienced periods of inflationary pressure. Over the past 50 years, global supply-driven shocks have triggered domestic cost-push inflation, which was often accommodated by expansionary policies. This paper analyses the historical trajectory of inflationary shocks in Greece, aiming to document inflation trends from the early 1970s to the present. In particular, it identifies the underlying forces that have driven inflation, which in turn entails an examination of both domestic demand and supply shocks, as well as global supply shocks. We find that there is a direct interplay between demand and supply shocks, global supply shocks that relate to geopolitical risk and Greek headline inflation.

In particular, the case study of Greece demonstrates that uncertainty arising from both country-specific shocks and global geopolitical shocks exerts a substantial influence on domestic headline inflation. In the presence of a global geopolitical shock, the impact is more enduring and substantial. The empirical evidence also suggests that domestic demand-driven shocks imply somewhat more persistent inflationary pressures compared to those produced by domestic supply-driven shocks. Moreover, the implementation of an inflation-targeting regime (or, in other words, an implicit monetary policy reaction function or a single monetary policy) effectively mitigates the potential adverse consequences of an inflation shock, regardless of its origin. It is evident that the manner in which monetary policy responds is subject to variation depending on the nature of the inflation shock in question.

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APPENDIX

Definitions of variables and data sources

Variable	Definition	Source
Headline global CPI inflation	Official CPI inflation; GDP-weighted average; annual averages; all goods and services	Ha, J., M.A. Kose and F. Ohnsorge (2023), Version: April 2024 update. https://www.worldbank.org/en/research/brief/inflation-database
Core global CPI inflation	Official CPI inflation; GDP-weighted average; annual averages; food and energy are excluded	Ha, J., M.A. Kose and F. Ohnsorge (2023), Version: April 2024 update. https://www.worldbank.org/en/research/brief/inflation-database
Headline CPI inflation-Greece	Official CPI inflation; GDP-weighted average; annual averages; all goods and services	Ha, J., M.A. Kose and F. Ohnsorge (2023), Version: April 2024 update. https://www.worldbank.org/en/research/brief/inflation-database
Euribor	Euribor 3-month - Historical close, average of observations through period (FM.M.U2.EUR.RT.MM.EURIBOR3MD_.HSTA) - Modified value (quarterly)	ECB portal to access SDW data
Real output growth rate	Quarterly real gross domestic product growth rate - annualised (t/t-4) (seasonally adjusted)	ELSTAT
Crude oil price	Crude oil prices: Brent - Europe, USD per barrel, quarterly, not seasonally adjusted	Federal Reserve Economic Data, Federal Reserve Bank of St. Louis. https://fred.stlouisfed.org
Harmonised ICP (HICP) inflation	All goods and services, annual average rate of change	Eurostat
Core CPI inflation	Food, energy, tobacco and alcohol are excluded; annual average rate of change	Eurostat
Goods	HICP; only goods; annual average rate of change	Eurostat
Services	HICP; only services; annual average rate of change	Eurostat
GPR	Global Geopolitical Risk Index; 1900-2019=100	Caldara and Iacoviello (2022), https://www.matteoiacoviello.com/gpr.htm
WUI-Greece	World Uncertainty Index for Greece. The index is normalised by total number of words and rescaled by multiplying by 1000.	Ahir, H., N. Bloom and D. Furceri (2022), https://worlduncertaintyindex.com/data/

WORKING PAPERS (JANUARY – JUNE 2025)

This section contains the abstracts of *Working Papers* authored by Bank of Greece staff and/or external authors and published by the Bank of Greece. The unabridged version of these texts is available on the Bank of Greece's website (www.bankofgreece.gr).

CONTENTS

Disaggregating VIX

Working Paper No. 335
Stavros Degiannakis and Eleftheria Kafousaki

This paper highlights the economic profits of markets' participants, accumulated from the disaggregated forecasts of the stock market's implied volatility, generated from an ensemble modelling architecture. The authors incorporate six decomposition techniques, namely, the EMD, the EEMD, the SSA, the HVD, the EWT and the VMD and four different model frameworks, those of AR, HAR, HW and LSTM, which are tested against a trading strategy, diverging from quantifying forecast accuracy solely on statistical loss functions and reporting the cumulative returns of short or long exposure on roll-adjusted VIX futures. The findings show that decomposing a time series into its intrinsic modes, prior to modelling and forecasting, can result in generating forecast gains which are translated into improved profits for trading horizons of 1 to 22 days ahead. Important trading implications are drawn from the results.

Trading VIX on volatility forecasts: another volatility puzzle?

Working Paper No. 336
Stavros Degiannakis, Panagiotis Delis, George Filis and George Giannopoulos

This paper evaluates the economic usefulness of stock market implied volatility forecasts, based on their ability to improve the short-run trading decision-making process. The current literature aligns the forecast horizon with the frequency of the trading decision in order to evaluate different forecasting frameworks. By contrast, the premise of the paper is that these should not necessarily be related, but rather the evaluation should be based on the actual needs of the end-user. Thus, it is evaluated whether the multiple days ahead stock market volatility forecasts vis-à-vis the 1-day ahead forecasts can improve the 1-day ahead trading profits from VIX and the S&P 500 futures. The results suggest that indeed the 1-day ahead trading profits are significantly improved when the trading decisions are based on longer-term volatility forecasts. More specifically, the highest trading gains are obtained when using the 22-days-ahead forecasts. The results hold true for both VIX and S&P 500 futures day-ahead trading. Although there is no theoretical background regarding the fact that forecasting and trading horizons should not be aligned, the authors strongly motivate this potential issue, both from the statistical and financial points of view.

Climate stress test of the global supply chain network: the case of river floods

Working Paper No. 337
Georgios Papadopoulos, Javier Ojea-Ferreiro and Roberto Panzica

This paper investigates how extreme flood events can indirectly impact the global supply chain through production disruptions. Using a data-driven, agent-based network model that combines company-level data with flood hazard maps, the research simulates the transmission and amplification of shocks. The findings emphasise that the size of inventories is

crucial; a lean-inventory system leads to faster shock propagation, higher losses and fewer recoveries compared to an abundant-inventory system. Additionally, it is identified that the number and criticality of flooded companies' trade links, along with the magnitude of the flood, correlate with the speed and severity of contagion. Interestingly, a key metric —the average criticality of affected firms' outgoing links— consistently peaks before the onset of the shock's fast-propagation regime. This could serve as an early warning indicator, giving businesses and policymakers precious time to react. By identifying these critical vulnerabilities, this paper provides a framework for enhancing the resilience of global supply chains in the face of increasing climate-related and other risks.

Stochastic debt sustainability analysis: a methodological note

Working Paper No. 338
Dimitrios Papaoikonomou

This paper mainly focuses on the approach taken at the Bank of Greece regarding the application of stochastic methods to debt sustainability analysis, also providing a discussion of alternative options. Caution is advised in the way that stochastic methods are made operational, as they are far from exact and rely on assumptions of various degrees of plausibility, which are often not stated explicitly. A Monte Carlo exercise reveals that, under the approach taken by the European Commission, the measurement of dispersion can be subject to significant bias, ranging from an over-estimation by 45% to an under-estimation in excess of 80%, depending on the time-series properties of the data.

The great dollar shortage debate: a modern perspective

Working Paper No. 339
Harris Dellas and George S. Tavlas

The dollar shortage debate —Paul Samuelson called it "the big open question of our time"— dominated international macroeconomics in the fifteen years following the end of World War II. The authors revisit it through the lenses of modern theory, namely, the intertemporal approach to the current account with financial frictions. They argue that its key elements, exemplified by the views of its main protagonist, Charles Kindleberger, have a remarkably modern flavour. Kindleberger identified the dollar shortage with the balance of payments deficit, a theoretically deficient but practically relevant and useful measure. He made early use of the permanent income/intertemporal approach to the current account and linked the persistence of trade imbalances to the income elasticities of savings and investment as well as to the persistence of U.S. technological superiority. The main shortcoming of the debate was the focus on the behaviour of the current account rather than on the capital account as the chief reason of the dollar shortage. The authors also argue that currency shortages in general, whether past or present, arise from financial frictions and can occur under different international monetary systems and financial systems.

Quantifying Federal Reserve credibility

Working Paper No. 340
Stephen G. Hall and George S. Tavlas

The authors derive an index that quantifies the Federal Reserve's credibility from 1965 until 2024. The credibility measure is derived by using the Kalman filter to extract an unobserved component from data, the movements of which are affected by central-bank credibility. They extend previous work using the Kalman filter in that they standardise the variables thought to affect credibility, so that the latter have zero mean and unit variance. Consequently, there is no need to estimate parameters in the Kalman filter measurement equations. The credibility index is used to identify seven historical episodes during which the degree of credibility differed.

Does primary and secondary education contribute to environmental degradation? Evidence from the EKC framework

Working Paper No. 341
Zacharias Bragoudakis and Emmanouil Taxiarchis Gazilas

This paper investigates the impact of education on the Environmental Kuznets Curve (EKC) hypothesis using a balanced panel dataset of 167 countries over 21 years. By employing three econometric models with CO_2 emissions, NO_x emissions and total greenhouse gas emissions as dependent variables, the authors analyse the role of primary and secondary education in shaping environmental outcomes. The results confirm the presence of an N-shaped EKC, suggesting that economic growth initially worsens environmental degradation, followed by an improvement, and later a potential rebound in emissions. More importantly, the authors find that education plays a significant role in environmental dynamics: higher enrolment in both primary and secondary education is associated with increased emissions, particularly in developing economies, possibly due to the expansion of industrial activity and energy consumption linked to a more skilled workforce. However, at higher levels of economic development, education may contribute to environmental awareness, innovation and policy implementation that foster sustainable practices. These findings highlight the need for targeted educational policies that integrate environmental sustainability to ensure long-term ecological benefits.

Navigating crude oil volatility forecasts: assessing the contribution of geopolitical risk

Working Paper No. 342
Panagiotis Delis, Stavros Degiannakis and George Filis

Media evidence and previous research have established that geopolitical risk is an important driver of crude oil price volatility. In this paper, the authors assess whether the importance of geopolitical uncertainty is also "translated" into valuable predictive information for oil price volatility forecasts. To do so, they construct a "beauty contest" where they assess the incremental predictive content of geopolitical risk against several other highly important uncertainty indicators, for a forecasting horizon up to 22-days ahead. Initially, the authors

use a HAR model which is augmented by each of the uncertainty indicators. Subsequently, they develop a Dynamic Model Averaging (DMA) methodology, where they assess whether the combination of all uncertainty indices (DMA-all), vis-à-vis a DMA model without the geopolitical uncertainty index, exhibits superior predictive performance. The findings show that geopolitical uncertainty offers superior predictive information when combined with other uncertainty indicators. More importantly, it is shown that the inclusion of geopolitical uncertainty in a DMA framework generates superior trading profits and risk management measures' predictions, in comparison with benchmark models, especially in longer-run horizons. Several implications are drawn from these results.

Formation, heterogeneity and theory consistency of inflation expectations in the euro area

Working Paper No. 343
Athanasios Angelis and Athanasios Tagkalakis

Using microdata from the European Consumer Survey (CES) for 11 European countries and 53 months, the authors investigate the formation and heterogeneity of inflation expectations as well as their theory consistency with the Phillips curve in the euro area, and across countries and demographic groups. They examine how individuals in the euro area form their inflation expectations. The findings show that people place significant weight on their current perception of inflation. Past experiences with prices also play a role, though to a lesser extent. Importantly, the formation of expectations tends to be forward-looking rather than backward-looking. A similar pattern emerges when the consistency of these expectations and perceptions is analysed with the Phillips curve theory. Individuals in the euro area generally do not hold theory-consistent expectations regarding inflation. The authors find notable variations across gender, age, income, education level and household size regarding the formation of inflation expectations.

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