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# GREECE

## SELECTED ISSUES

January 2024

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# GREECE

## SELECTED ISSUES

December 15, 2023

Approved By
**European Department**

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## CONTENTS

**FIGURES**



**APPENDICES**



**FIGURES**



**APPENDICIES**

# THE COST-OF-LIVING CRISIS: IMPACT AND POLICY SUPPORT TO HOUSEHOLDS, EVIDENCE FROM MICRO-LEVEL DATA[1]

*The Greek government has provided substantial support to households and enterprises to cope with the high cost of living in 2022—2023. This paper leverages on the rich micro-level data on household consumption in Household Budget Survey to study the distributional impact of price increases. It finds that low-income households and households living in sparsely populated areas and/or relying more on secondary source of income (e.g., non-wage income) have faced higher loss of purchasing power, despite significant heterogeneity even within narrowly defined household groups. Policy simulations suggest that targeted support measures tailored to the recipients' needs would effectively mitigate the vulnerable households' income loss. Categorical programs that aim at a certain group of households without income criteria could also alleviate the cost-of-living pressures, but less effectively.*

## A. Motivation

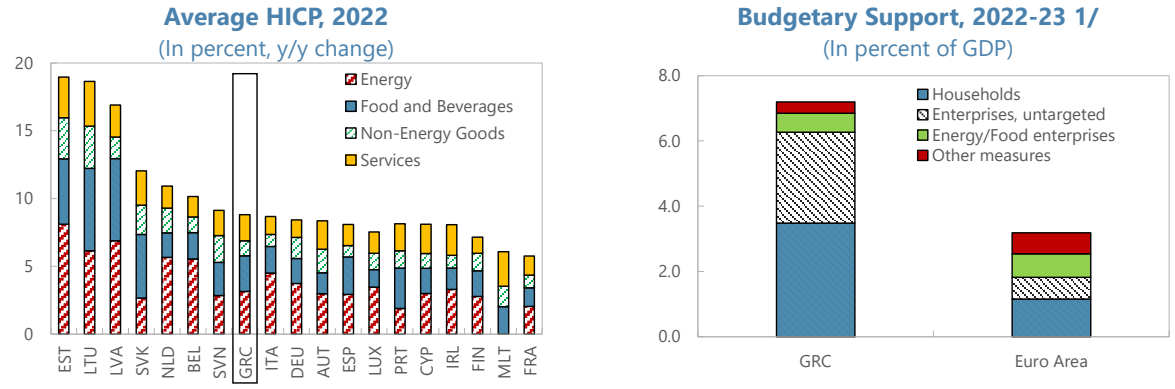
**1. The sharp rise in energy bills and food prices spurred high inflation in Greece and led to substantial government support in 2022–23.** Average inflation shot up to almost 10 percent in 2022 from a marginally positive rate in 2021, with two thirds of the price increase accounted for by food, beverage, and energy. In reaction, the government provided significant subsidies on electricity differentiated by usage, along with other budgetary measures to alleviate the skyrocketing living and operating costs facing households and enterprises. Most of the measures are expected to be withdrawn by end-2023 as energy prices and the headline inflation normalize, except for some electricity subsidies for small users. Given the record high inflation and sizable government support programs, it would be of interest for policymakers to gauge the impact of price increases on individual households and how government interventions effectively reach the vulnerable. This paper uses the rich household consumption data in the annual Household Budget Survey (HBS) to study these policy relevant questions.

**2. There is substantial heterogeneity in households' consumption patterns across different income groups.** As expected, households allocate a smaller share of their total consumption on basic goods such as food and utilities as the total household income increases. Notably, households in the bottom income quintile spend over 20 percent of their total expenditure on housing, water, electricity, gas, and other fuels, more than double the corresponding share for households in the top income quintile. In contrast, services such as transport and accommodation and restaurants are more prominent in the consumption baskets for well-off households. The COVID-19 pandemic triggered some behavior changes as households substituted services involving

[1] Prepared by Shiqing Hua and Wei Shi. The paper has benefited from comments, discussions, and additional references provided by the Greek authorities.

close human interactions (travel, hotel, restaurants) for goods in 2020, but 2021 saw signs of households reverting to their old consumption patterns with rising share of services at the cost of lower consumption in foods and utilities. This trend could be checked in 2022 when food and energy prices jumped up.

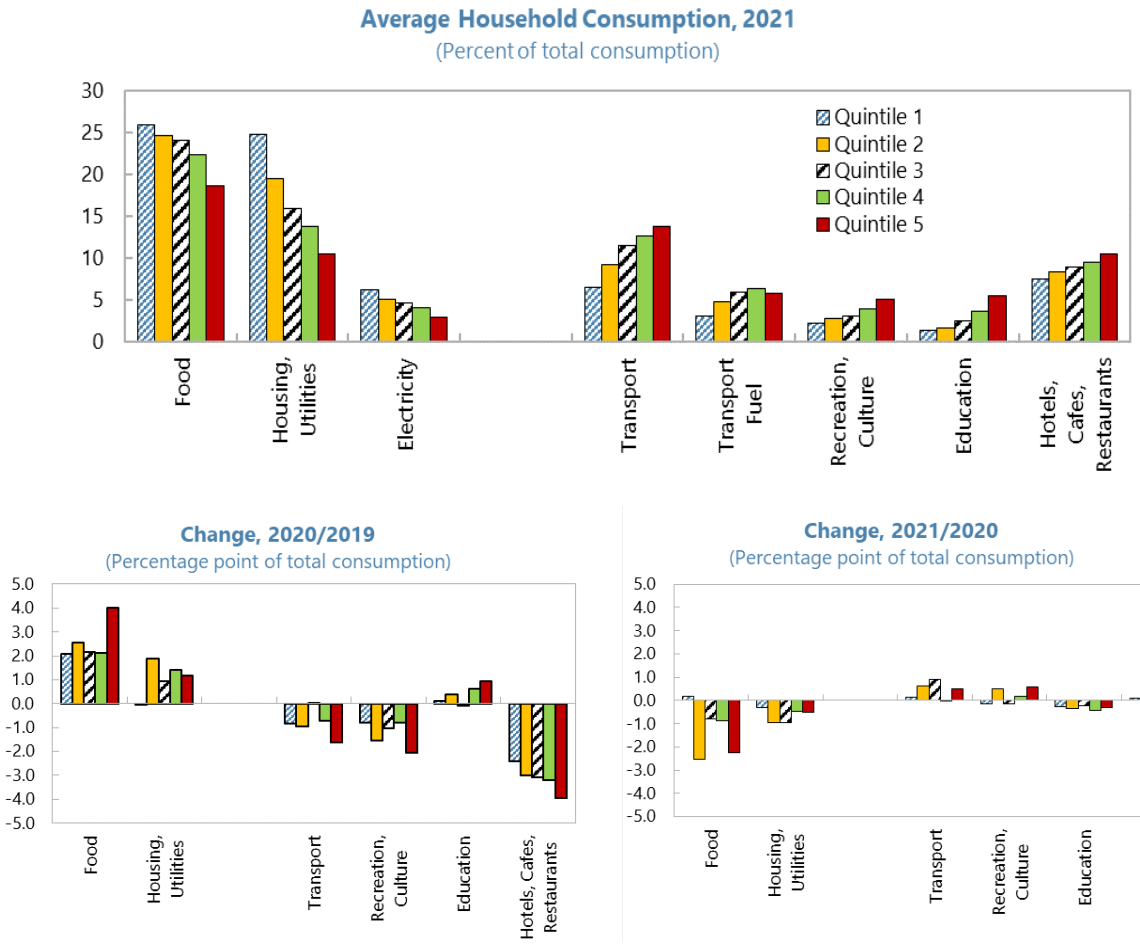
**Figure 1. Greece: Cost of Living and Fiscal Support, 2022–23**




Sources: Eurostat; Haver Analytics; Updated results of the DEFPA IMF Country Desk Survey from Amaglobeli and others (2023); and IMF staff calculation.
1/ refers to estimated cost of relevant budgetary spending. The net budgetary impact is much smaller given the sizable windfall revenue from the energy sector.

**3. The impact of inflation on households' cost of living is highly uneven as price increases are not uniform across consumption categories.** The differentiated impact of the recent energy price surge across household income distribution has been noted in a few working papers (Ari and others (2022), Arregui and others (2022), Charalampakis and others (2022)). Causa and others (2022) focuses on the impact of the general price rises by calculating the loss of household purchasing power as a result of higher prices (the compensating variation) and correlates it with household characteristics (e.g., income, place of residence). This paper applies a similar approach to Greece. It constructs the change in households' purchasing power induced by price increases for a detailed basket of goods and services that the Greek households consume (Section B). To demonstrate the added value of granular information in policy-making, it also presents policy simulations to illustrate the distributional impact of various policy instruments that could be used to support vulnerable households (Section C). Further discussions on the methodology, data, and robust checks are given in the appendix.

**Figure 2. Greece: Selected Household Consumption Indicators**




Sources: Hellenic Statistical Authority (ELSTAT), Household Budget Survey (HBS); and IMF staff calculations.
Notes: Quintiles are calculated based on total household income in HBS. The imputed rentals for housing (HE042) are excluded from households' consumption basket as it is not included in the Harmonized Index of Consumer Prices (HICP).

## B. Distributional Impact of Inflation

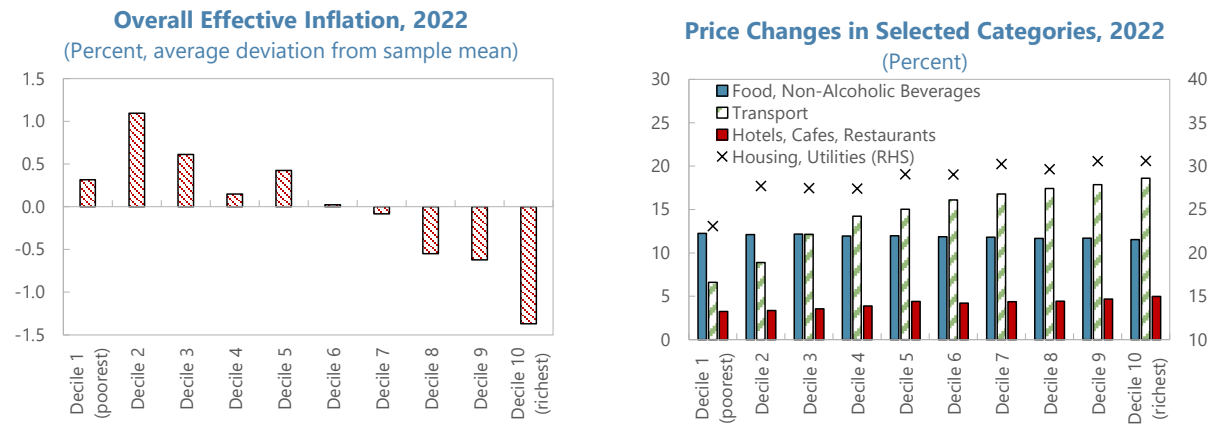
**4. This paper analyzes the distributional impact of the recent price surge using a micro-based granular indicator of the effective inflation facing each household.** We follow the framework originally proposed by Deaton (1989) and look at how much the household needs to be compensated so that it can avoid a deterioration of welfare. In practice, we approximate the needed compensation expressed as a share of household expenditure by the weighted sum of price changes for goods and services the household consumes, taking as weights their expenditure shares in the old consumption bundle (proxied by consumption patterns as in the 2021 HBS).[2] Without such an increment to the household budget, the household will have to abandon its old consumption basket and settle with a less costly and probably less desirable consumption bundle. Thus, the indicator can be interpreted as a measure of the loss in purchasing power induced by the price increases. To get as

[2] See the formula, illustrative examples, and further discussions in the appendix.

close as possible to households' consumption baskets, instead of sticking to major consumption categories as done in recent IMF working papers, we construct the indicator using detailed goods and services to the extent that their prices are separately observed in the HICP, and their expenditure shares can be calculated for each household in the HBS. Henceforth, we will refer to this indicator as the effective inflation.

**5. The effective inflation shows substantial variations among households, with lower-income households having experienced a greater loss of purchasing power.** On average, the effective inflation for households in the top three income deciles is 1½ percentage points below that for households in the bottom three income deciles, confirming that poorer households are indeed hit harder by the negative income shock during the inflation episode. The excess of effective inflation faced by poorer households mainly stems from the compositional factor—compared to their total expenditure, these households consume disproportionally more consumption items that saw large price increases (food, utilities). While restricted to major consumption categories, richer households have experienced in most cases higher increases of the costs of their bundles, especially in utilities and transport which are heavily influenced by international energy prices. The exceptions are in food and non-alcoholic beverages, and health, where the cost increases during 2022 are marginally higher for poorer households.

**Figure 3. Greece: Effective Price Changes by Income Decile**



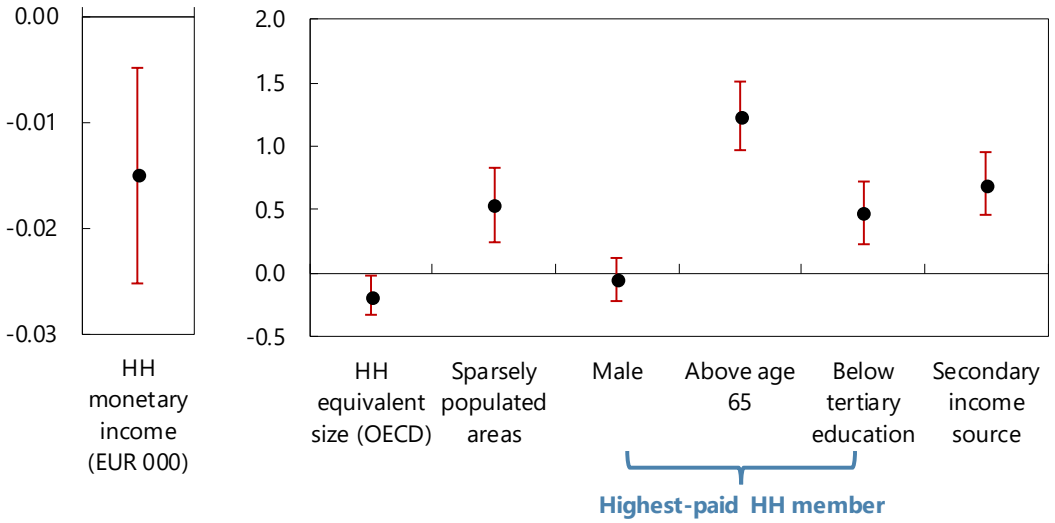

Sources: ELSTAT, HBS; Eurostat; Haver Analytics; and IMF staff calculation.
Note: The effective inflation shown on the left is the deviation from the estimated sample mean.

**6. The effective inflation is also correlated with other household characteristics.**[3] Large households on average spend a smaller share of their income on utilities, which leads to a less sharp increase in their effective inflation. In contrast, households whose major bread-earners are around the retirement age (above age 65) or less educated spend more on utilities and food, and therefore would see a more sizable increase of their living expenses associated with their old consumption baskets. This also holds for households which declare their main income source to be secondary, i.e.,

[3] We isolate these correlations in a multi-variate regression setting controlling for household income and regional dummies. See the appendix for the regression table.

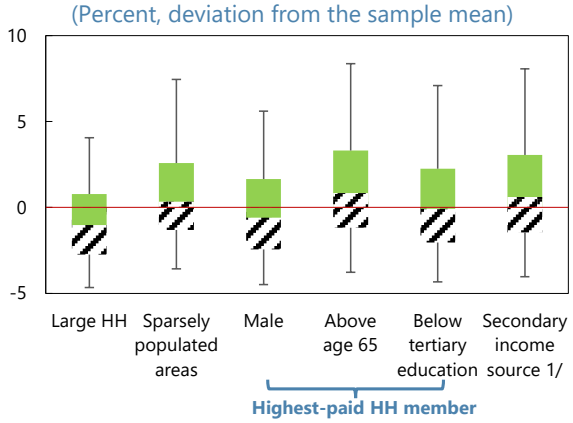
from pensions, unemployment benefits, or other non-wage, non-property income. There is no statistically significant difference in the correlation identified regarding the gender of the major bread-earner: among items that have seen fast price increases, female-headed households tend to spend more on food, utilities, and health, while male-headed households tend to spend more on alcoholic beverages and tobacco, transport, and restaurants and hotels. Lastly, due to the higher share of their budget allocated to food and to a lesser extent utilities, households living in sparsely populated areas are found to be facing a higher effective inflation.

**Figure 4. Greece: Effective Inflation vs. Household Characteristics 1/**



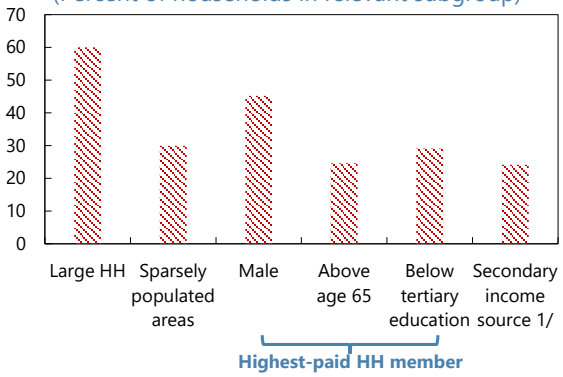

**Effective Inflation among Households 2/**

(Percent, deviation from the sample mean)




**Share of Households with Above Average Income**

(Percent of households in relevant subgroup)




Sources: ELSTAT, HBS; Eurostat; Haver Analytics; and IMF staff calculation.

1/ Secondary income in HBS is defined as income from pensions, unemployment benefits, and other non-salary, non-property income. The red bars denote the 95-percent confidence intervals around the point estimates. The underlying regression results are presented in Appendix Table 3, 1st column.

2/ The green box denotes the range of effective inflation between 50th to 75th percentiles, the black dashed box shows the range of effective inflation between the 25th to 50th percentiles. The whiskers extend to the 95th percentile of the effective inflation above and 5th percentile below. The large household category refers to households whose OECD equivalent sizes are above the sample median.

**7. There are still significant differences even within narrowly defined household groups, suggesting the importance of granular information for effective policy support.** For instance, among groups that have been identified above as facing on average higher effective inflation, there are still a significant share of households experiencing below-average effective inflation. The share is close to 50 percent for households living in sparsely populated areas or with the highest-paid member having an education below tertiary, and around 40 percent for households relying on secondary income sources or with the highest-paid member above age 65. These households also differ in their income endowment, which is another crucial factor to be considered when deciding on extending government support. Though the aforementioned four groups are indeed more likely to have below-average income, there is nonetheless a critical mass of around 30 percent of households with above-average income within each group. In short, the granular information regarding household-level income and effective inflation could help identify vulnerabilities and guide effective policy interventions. We illustrate the possible benefit in the next section through policy simulations.

## C. Policy Simulations

**8. Greece has provided subsidies and income transfers to support households, while refraining from imposing price controls during the energy price surge.** Due to data limitation, simulations presented in this section are not able to replicate the actual government interventions undertaken during 2022–23.[4] Rather, we design hypothetical scenarios that capture basic properties of subsidies and transfers in the absence of income-targeting and show how targeting enabled by household-level knowledge could better alleviate the cost-of-living pressures for the vulnerable. In the simulations, subsidies are defined as the additional cash each recipient household receives proportional to its consumption of the subsidized products,[5] while categorical transfers are the cash payments to households belonging to certain categories. Under the assumption that household income is not observed or cannot be verified, all eligible households are assumed to receive an equal amount of transfer, or in the case of child benefits, all children below age 16 are entitled to an equal amount of transfer. It is worth reiterating that the simplified scenarios are used to demonstrate the distributional impact of pre- and post-intervention effective inflation among households and to empirically illustrate whether these instruments are more capable of reaching the vulnerable. Their sizes and specific designs in the simulations are not intended to be taken at face value as policy recommendations.

**9. As a benchmark, we simulate the impact of a hypothetical "targeted transfer" with respect to household income.** Under the targeted transfer scenario, all households in the bottom three income deciles that have experienced above-average effective inflation are given cash so that

[4] For instance, for energy subsidies, the HBS has only information on households' energy bills, but the actual interventions are based on households' usage of electricity/natural gas which have been found in a recent ECB paper as largely closing the gap of welfare loss across the household income distribution in Greece. See Antonio F. Amores and others, *Inflation, Fiscal Policy and Inequality the Distributional Impact of Fiscal Measures to Compensate for Consumer Inflation*, ECB Occasional Paper Series, No. 330.

[5] In particular, energy subsidies in the simulation are implemented against HBS category 045 (electricity, gas, and other fuels), while food subsidies are implemented against HBS category 011 (food).

their loss of purchasing power is reduced to the rate of average (pre-intervention) effective inflation. After the intervention, the mean effective inflation within the bottom three deciles will be brought down to around 1½–2 percentage points below its original levels, or 1½ percentage points below the original sample average, comparable to the level of the top decile.[6] Such intervention will not affect the top seven deciles and has a fairly modest policy objective for the bottom three deciles—the affected households continue to face a loss of their purchasing power equal to the sample average (around 10 percent)—and thus has a moderate fiscal cost (0.1 percent of GDP). To ensure comparability among different simulated scenarios, we calibrate the subsidies and categorical transfers so that the overall fiscal envelope is equal to the fiscal cost of the targeted transfer scenario. In reality, however, policymakers should calibrate the magnitude of the policy interventions according to the available fiscal space, other competing budgetary spending needs, and social-economic conditions of households.

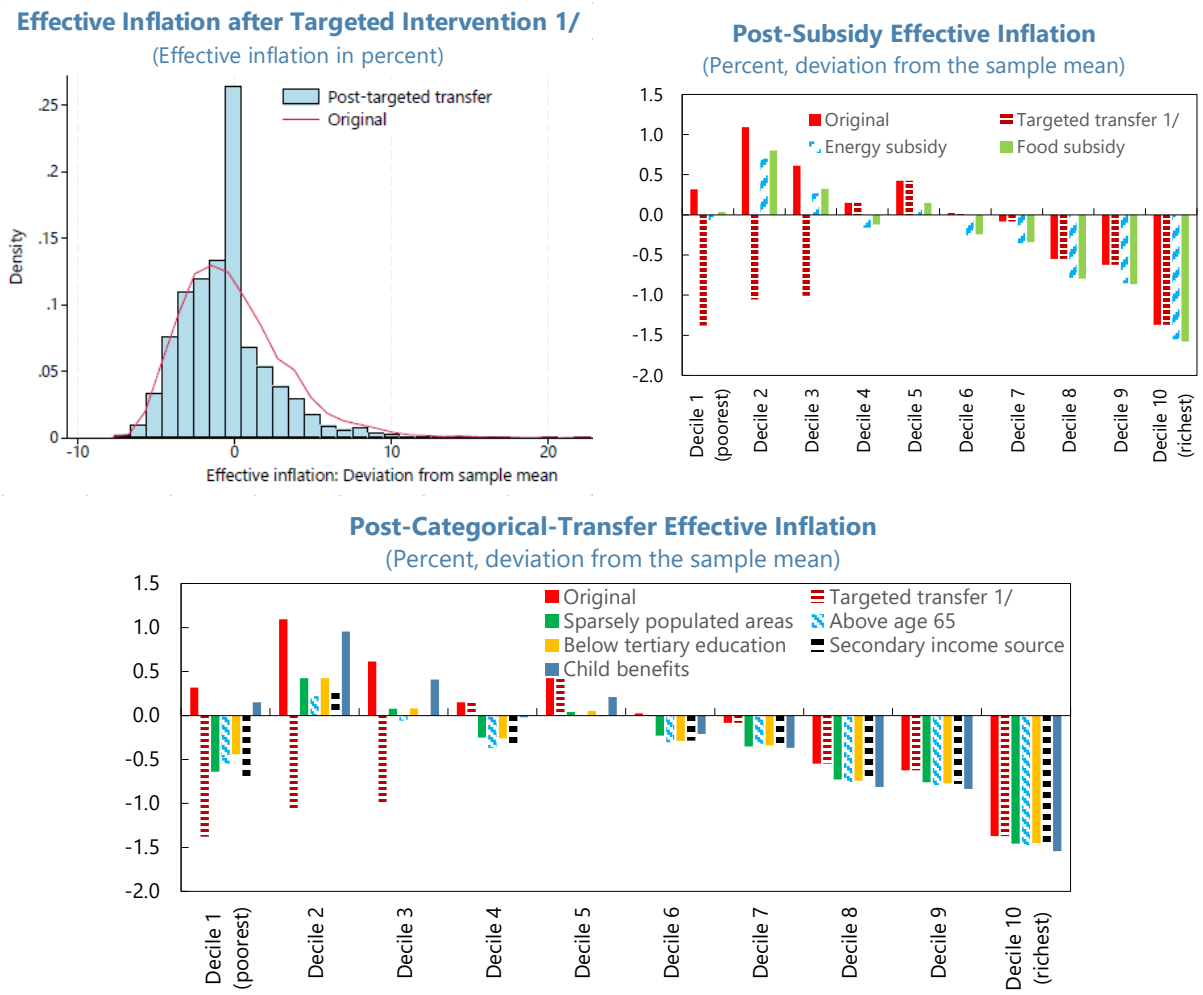
**10. Both subsidies and categorical transfers to households help reduce the effective inflation facing low-income households to varying degrees.** All instruments other than the targeted transfers benefit to some extent households in upper income deciles. Subsidies are known to be regressive as their benefits are proportional to the consumption of the subsidized goods/services, and the rich are more likely to consume more. Hence, the effective inflation for the bottom three deciles only sees a limited reduction after the policy intervention as a significant share of benefits (75 percent for energy subsidies and 80 percent for food subsidies) are received by higher-income households. Categorical transfers in a few cases are more effective in reaching the vulnerable than subsidies. Micro-level information in HBS suggests that living in sparsely populated areas, relying on secondary income sources, and major bread-earner being around retirement age or of less than tertiary education, are reasonably well correlated with both lower household income and consumption patterns that give rise to higher effective inflation during the inflation episodes as observed in 2022. However, even with these instruments, the ability to support the poor and vulnerable compare less favorably with a targeted transfer. To illustrate, against a pre-intervention share of 51.5 percent of households in bottom three deciles facing above-average effective inflation, the share drops to zero by design in the targeted transfer scenario, while it remains elevated (above 40 percent) for all simulated categorical transfers. The lower effectiveness of categorical transfers is again due to the linkage of benefits to households with higher income: Out of all benefits provided, around 60 percent would be received by households in the top seven deciles, which presents a notable improvement relative to subsidies but still leaves ample room for further enhancement.

**11. The hypothetical policy simulations suggest that targeted policy support would be the most effective way to alleviate the high cost of living for the vulnerable households.** This is particularly the case under a fixed fiscal envelope as the less benefits leak to other groups, the more resources can be directed to those that the policy intervention aims to protect. However, if income is at high risk of being mis-reported by households, income-targeted support becomes less effective. In practice, the actual interventions of electricity subsidies have a quasi-targeting element that

[6] The top-left panel of Figure 5 illustrates how the distribution of effective inflation changes after imposing the targeted transfers to the bottom three deciles. The dash red bars next to the solid red bars in the top-right panel and the bottom panel show the average effective inflation within each decile after the targeted transfers.

reduces the unit-subsidy for large users (presumably richer households), and thus should have a more progressive distributional impact among households than the simulated energy subsidy scenario. Similarly, the food program ("Market pass") also incorporates some income criteria and would be more effective to support low-income households than in the simulation. Nonetheless, the simple simulations have demonstrated the importance to recognize household heterogeneity and the value to incorporate it into policy design and implementation. Going forward, more efforts are warranted to continue build capacity to implement targeted programs via establishing a centralized registry of beneficiaries, improving reporting and verification of beneficiaries' income leveraging on available third-party information, and addressing gaps in coverage and benefit levels of existing targeted programs such as the Guaranteed Minimum Income.

**Figure 5. Greece: Simulations of Support to Households**




Sources: ELSTAT, HBS; Eurostat; Haver Analytics; and IMF staff calculation.
1/ The targeted transfers are designed to compensate households originally in the bottom three income deciles for the excess loss of real income benchmarked by the average effective inflation over the whole sample. The distributional impact after policy interventions is calculated using the original income deciles, and the deviations presented in the figure are calculated relative to the pre-intervention sample mean.

# Appendix I. Description of Methodology, Data, and Robustness Checks

***Methodology and Data***

**1. As in Causa and others (2022), this paper quantifies the impact of price changes on households' consumption by calculating the compensating variation.** For household $i$ with consumption bundle $\{c_0^{i,j}\}$ over a basket of goods and services indexed by $j$, when prices change from $\{p_0^j\}$ to $\{p_1^j\}$, the compensating variation is calculated as

$\mathrm{CV}_{0,1}^{\mathrm{i}} = \Sigma_j s_0^{i,j} \cdot \pi_{0,1}^{\mathrm{j}}$, where the share $s_0^{i,j} = \frac{c_0^{i,j} p_0^j}{\Sigma_k c_0^{i,k} p_0^k}$, and the price increase $\pi_{0,1}^j = 100 \cdot \left(\frac{p_1^j}{p_0^j} - 1\right)$.

Source: ELSTAT, Household Budget Survey (HBS); and IMF staff.

It measures the minimal change in household expenditure—expressed as a share of total expenditure under old prices $\{p_0^j\}$—that is needed to make the old consumption bundle $\{c_0^{i,j}\}$ affordable under new prices $\{p_1^j\}$. In the case of a general price increase, thus calculated compensating variation will be positive, meaning that the household's old consumption bundle becomes more expensive. In other words, the compensating variation indicates the extent that the household's purchasing power shrinks due to the price increases, and therefore can be viewed as a measure of the effective inflation facing the household.[1]

**Appendix I. Table 1. Greece: Major Consumption Categories in HBS**

| | |
|---|---|
| 01 | Food and Non-Alcoholic Beverages |
| 02 | Alcoholic Beverages, Tobacco, and Narcotics |
| 03 | Clothing and Footwear |
| 04 | Housing, Water, Electricity, Gas and Other Fuels |
| 05 | Furnishings, Household Equipment and Routine Household Maintenance |
| 06 | Health |
| 07 | Transport |
| 08 | Communication |
| 09 | Recreation and Culture |
| 10 | Education |
| 11 | Restaurants and Hotels |
| 12 | Miscellaneous Goods and Services |

Source: ELSTAT, Household Budget Survey (HBS); and IMF staff.

[1] If the household re-minimizes the cost under new prices $\{p_1^j\}$ subject to that its utility is at least the same as offered by the old bundle $\{c_0^{i,j}\}$—which now costs $\left(1 + CV_{0,1}^i\right)$ times the initial spending—the optimal bundle could be less costly. Hence, the household could manage to achieve the same utility with a smaller increase in its consumption expenditure, thus the compensating variation indicates an upper bound of the real income drop felt by the household following the given price increases.

**2. Calculating the compensating variation requires two pieces of information: the share of a given consumption category in the total household budget and the change of its price (average 2022 over 2021).** The consumption share is computed from the 2021 Household Budget Survey (HBS), which records in monetary units the surveyed household's spending on twelve major categories of goods and services (coded with two digits, see Appendix I. Table 1.), as well as a more detailed breakdown into subcategories (coded with three-to-five digits, see examples in Appendix I. Table 2). These consumption categories can largely be mapped into goods and services used to compile the Harmonized Index of Consumer Prices (HICP), which provides information on price changes. [2]

**Appendix I. Table 2. Greece: Illustrative Examples**

- 111 — Catering services
  - 1111 — Restaurants, cafes, and the like
    - 11111 — Restaurants, cafes, and dancing establishments
    - 11112 — Fast food and take-away food services

    **Finest categories**
  - 1112 — Canteens
- 0432 — Services for the maintenance and repair of dwelling
  - 04321 — Services of plumbers
  - 04332 — Services of electricians
  - 04323 — Maintenance services for heating system
  - 04324 — Services of painters
  - 04325 — Services of carpenters
  - 04329 — Other services

  **Non-HICP categories. Price changes are calculated as the weighted (by HICP weights) average inflation of 04321–04323**

Sources: ELSTAT and IMF staff.

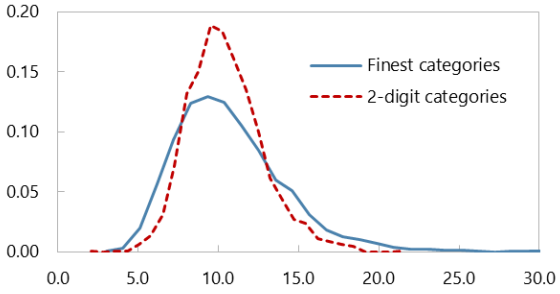
**3. We construct the household-specific compensating variation to mimic the aggregate HICP while trying to go as granularly as possible with respect to consumption categories.** To illustrate, for catering services (111, under major category 11 "Restaurants and Hotels") shown in Appendix I. Table 2., we skip 1111 ("Restaurants, cafes, and the like"), and include its two finer subcategories 11111 ("Restaurants, cafes, and dancing establishments") and 11112 ("Fast food and take-away food services") in the calculation instead. On the other hand, the parallel subcategory 1112 ("Canteens") is already the finest classification and thus is included directly in the calculation. Since the mapping between the HBS categories and the HICP categories are not perfect, adjustments are made to align the calculated compensating variation more closely to the HICP concept. These include (i) excluding the imputed rentals for housing (042) when calculating the HBS consumption share as the imputed rentals are not part of the HICP; (ii) for those goods and services surveyed in the HBS but not covered in the HICP (e.g., 04324–04325 and 04329 under 0432 "Services for the

[2] Based on Eurostat and Haver Analytics. It should be noted that the consumption basket underlying the HICP differs from the one underlying the domestic consumer price index (CPI), which could be more relevant for households.

Maintenance and Repair of Dwelling" in Appendix I. Table 2.), extrapolating their price changes as the weighted average of price changes for goods/services classified under a common overarching category (e.g., 04321–04323 which are also under 0432) using the HICP weights.

**4. The granular approach with respect to consumption categories helps capture vulnerabilities arising from the diverse consumption behaviors at the household level.** Households could have consumption baskets highly skewed towards particular goods or services whose price increases outpaced the aggregated price indices. As can be seen from Appendix I. Figure 1., the empirical distribution of household-specific inflation calculated from the finest categories of goods and services (in blue) has fatter tails compared to the one calculated using only the twelve major categories (in red), though the two distributions have similar means and modes. Households located on the right tail are potentially more vulnerable to the inflation shock, especially for those with relatively modest income.

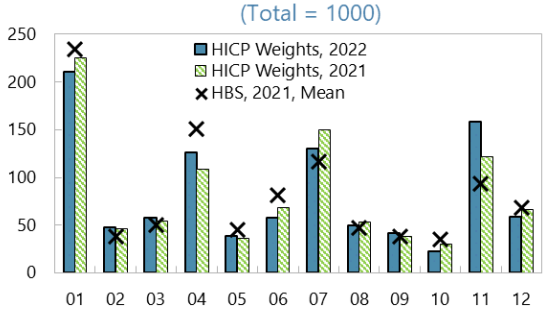
**Appendix I. Figure 1. Greece: Empirical Density Functions of Calculated CVs**




Source: IMF staff calculation.
Note: Gaussian kernel is used, and the probability weight is approximated by the frequency weight.

**5. It should be noted that the granular approach comes with some costs and caveats.** The rounding errors of HICP weights and year-on-year changes of indices accumulate and become nontrivial. The bottom-up approach to reconstruct the HICP from 355 major and minor categories of goods and services yields an average inflation of 9.5 percent versus the official number of 9.3 percent. The accumulated rounding errors are particularly pronounced for utilities (04) which experienced the sharpest increases in prices, but also for other high-inflation categories such as food (01) and transport (07). Moreover, the average consumption shares in the HBS do not correspond to the HICP weights (Appendix I. Figure 2.), with notably higher average shares for food, housing and utilities, and health in 2021. As a result, the calculated compensating variation averages 10.3 percent in 2022, exceeding the average HICP inflation (9.3 percent, corresponding to the 32th percentile of the calculated compensating variation).[3]

**Appendix I. Figure 2. Greece: Average HBS Share vs. HICP Weights**
(Total = 1000)




Sources: Eurostat; Haver Analytics; ELSTAT, HBS; and IMF staff calculations.

[3] It may be worth stressing that though the compensating variation is constructed based on the same consumption bundle as the HICP, its goal is to capture the changing costs of living associated with price changes for individual households. Hence, the weights used to construct the compensating variation are intended to reflect the households' hypothetically desirable consumption bundles, rather than those underlying the actual aggregate price changes. In this sense, the two concepts are not comparable.

***Robustness Checks***

**6. The empirical correlations identified between the effective inflation and household characteristics are robust to alternative specifications.** The first column of Appendix I. Table 3. shows the baseline regression results quoted in Section B which take into account the sampling design features, i.e., the strata, sampling units, and sample weights. The coefficients are found to be robust to assuming random sampling among households (Column 2, the ordinary least square), alternative measures of the key variables (Column 3 with total income instead of monetary income, OECD modified scale for household size, and characteristics of the reference person as defined by the HBS rather than the highest-paid household member), breaking down of detailed income sources (Column 4 with reference to income sources from self-employment, pension, and unemployment benefits considered separately), and the inclusion of additional household characteristics (Column 5 with the marital status and if the highest-paid member is below age 25, works full-time or in the public sector, or has a permanent contract).

## Appendix I. Table 3. Greece: Effective Inflation vs. Household Characteristics 1/

| VARIABLES | (1) Baseline | (2) OLS | (3) | (4) | (5) |
|---|---|---|---|---|---|
| Dummy: Sparsely populated areas | 0.5414*** | 0.4906*** | 0.5676*** | 0.4930*** | 0.5199*** |
| | (0.1489) | (0.1058) | (0.1492) | (0.1486) | (0.1493) |
| Household monetary income (EUR 000) | -0.0150*** | -0.0159*** | | -0.0164*** | -0.0160*** |
| | (0.0052) | (0.0039) | | (0.0057) | (0.0059) |
| Household total income (EUR 000) 2/ | | | -0.0078** | | |
| | | | (0.0038) | | |
| Household equivalent size (OECD) | -0.1750** | -0.3019*** | | -0.1857** | -0.2701*** |
| | (0.0808) | (0.0704) | | (0.0837) | (0.0874) |
| Household equivalent size, modified (OECD) | | | -0.2783** | | |
| | | | (0.1102) | | |
| Dummy: Highest-paid household member is | | | | | |
| Male | -0.0477 | -0.0759 | | -0.0633 | -0.1252 |
| | (0.0868) | (0.0895) | | (0.0860) | (0.0962) |
| Above age 65 | 1.2321*** | 1.1878*** | | 0.9591*** | 1.1622*** |
| | (0.1370) | (0.1188) | | (0.1415) | (0.1401) |
| Below tertiary education | 0.4767*** | 0.4954*** | | 0.4789*** | 0.5166*** |
| | (0.1279) | (0.1049) | | (0.1325) | (0.1314) |
| Below age 25 3/ | | | | | -1.0728*** |
| | | | | | (0.3716) |
| Dummy: Reference household member is | | | -0.0109 | | |
| Male | | | (0.0953) | | |
| Above age 65 | | | 1.2641*** | | |
| | | | (0.1421) | | |
| Below tertiary education | | | 0.3036*** | | |
| | | | (0.1023) | | |
| Dummy: Main source of income is secondary | 0.7035*** | 0.6203*** | 0.7555*** | | 0.8628*** |
| | (0.1270) | (0.1212) | (0.1271) | | (0.1760) |
| Dummy: Main source of income is | | | | | |
| Self employment 3/ | | | | 0.2713** | |
| | | | | (0.1347) | |
| Pension | | | | 1.0585*** | |
| | | | | (0.1405) | |
| Unemployment benefits 3/ | | | | 0.9479** | |
| | | | | (0.4719) | |
| Dummy: In a marriage | | | | | 0.2459* |
| | | | | | (0.1311) |
| Observations | 6,047 | 6,047 | 6,055 | 6,047 | 6,047 |
| R-squared | 0.2039 | 0.2057 | 0.1992 | 0.2080 | 0.2071 |
| Constant | YES | YES | YES | YES | YES |
| Regional dummies | YES | YES | YES | YES | YES |
| Sampling design features | YES | NO | YES | YES | YES |
| Additional household characteristics | NO | NO | NO | NO | YES 4/ |

Source: ELSTAT, HBS; and IMF staff calculation.

1/ Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Income taxes are excluded from household monetary income. Secondary income source refers to pensions, unemployment benefits, and other current benefits or income.

2/ Including both monetary and non-monetary income. There are 8 households reporting no monetary income.

3/ Relatively few observations in HBS.

4/ These additional characteristics are that the highest-paid member works full-time, or has a permanent contract, or works in the public sector. Among these, only the permenant contract indicator has a marginally significant coefficient (0.32).

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# MACROPRUDENTIAL POLICY CALIBRATION FOR GREECE: SIMULATIONS FOR BORROWER-BASED MEASURES[1]

*The Greek financial system has remained resilient underpinned by strengthening banks' balance sheets, but still faces significant challenges ahead including the re-emergence of imbalances in the real estate market. Recognizing these imbalances, the authorities have recently introduced the necessary legal framework for setting borrower-based measures (BBMs), paving the way to activate both income- and collateral-based measures in near term. Simulations, which employ a quantitative framework combining micro- and macro-level data, show that BBMs would help enhance household resilience, with synergies when caps on debt service-to-income (DSTI) and loan-to-value (LTV) ratios are jointly implemented, leading over time to the more resilient banking system against potential risks. Caps could initially be set at less binding levels and gradually tightened based on a systemic risk assessment.*

## A. Introduction

**1. The authorities have embarked on policy initiatives to strengthen macroprudential policy toolkit against emerging vulnerabilities in the real estate market.** In line with IMF (2022) and ESRB (2022), the Bank of Greece (BoG) has been monitoring the developments in the real estate markets, having identified rapid increases in residential prices as one of the important albeit still emerging systemic risks. The systemic importance of real estate markets stems from the strong link between them and significant parts of the economy, underscoring the importance of real estate markets from a macroeconomic and financial stability perspective. (ESRB, 2019). In an effort to address these risks, the underlying legal framework has recently come into effect granting the BoG the power to enact macroprudential borrower-based measures (BBMs) to be implemented in Greece (BoG, 2023a).

**2. The toolkit embedding BBMs can help reduce systemic risk by enhancing the resilience of households and banks**. These measures directly constrain new credit flows by imposing limits on the amount of credit that a specific borrower can obtain, typically in relation to the value of the underlying collateral and/or the borrower's income. While BBMs do not have an immediate impact on banks' capacity to absorb losses, they gradually reduce the magnitude of potential future bank losses by making households more resilient to income, interest-rate, and house-price shocks (Behn and others, 2022). BBMs could complement capital-based measures (CBM), which are unlikely to

[1] Prepared by Marco Gross, Shiqing Hua, Mariusz Jarmuzek, and Wei Shi, with inputs from Katherine Dai. The authors would like to thank, without implicating, Heather Gibson, Dimitris Malliaropulos, Eleftherios Manarolis, Michael Massourakis, Paavo Miettinen, Erlend Nier, Spyros Pantelias, Ellen Ryan, Nikos Stavrianou, and Ioannis Tsikripis, as well as participants of the workshop held at the Bank of Greece for useful discussions, comments, and suggestions.

have a material impact on borrower risk characteristics or the magnitude of expected future losses, but, importantly, they enhance banks' capacity to absorb losses.[2]

**3. The paper presents key trade-offs and some initial benchmark calibration of BBMs for Greece**. After a select dive into systemic risk in the household sector and real estate markets along with providing basic rationale for and modalities of BBMs, the study focuses on answering two policy questions: (1) what could be the impact of introducing BBMs on household resilience taking into account negative macroeconomic feedback loop effects? (2) what could be the impact of introducing BBMs on bank resilience?

## B. Select Systemic Risk Assessment

**4. There are emerging sings of imbalances in the real estate sector (Figure 1)**. Residential real estate prices have increased significantly across the board of indicators since its trough in 2017, exceeding 50 percent in nominal terms and 35 percent in real terms and not yet visibly decelerating, supported by strong employment and real disposable income growth. Demand also stemmed from nonresidents who increased significantly their investment in the real estate market taking inter alia advantage of the Golden Visa program, which came on top of structural issues pointing to Greece as being one of the countries with the lowest number of rooms per person and the highest share of population living in overcrowded homes in the EU. But there was a significant supply response, with housing investment as a share of GDP and building permits doubling since 2016, although admittedly from a low base. Various metrics suggest moderate overvaluation in 2023, with the price-to-income and price-to-rent ratios exceeding their historical long-term averages by 6 and 29 percent, respectively, which is broadly confirmed by the results of the econometric model suggesting 8 percent.

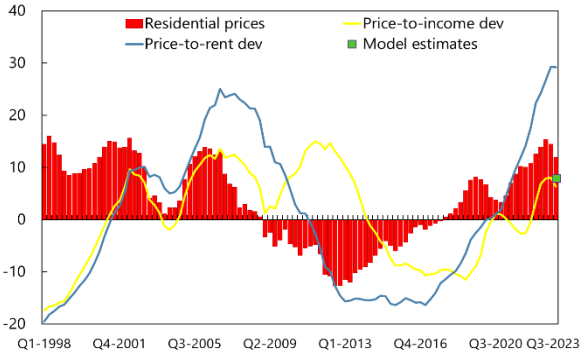
**5. While the household sector leverage and banking exposure to the real estate sector have declined since the sovereign debt crisis, there appear to be some vulnerabilities requiring close monitoring (Figure 2)**. The household sector debt was subject to a pronounced deleveraging process following the global financial crisis (GFC), resulting in much lower leverage levels compared to other EA countries. Reflecting the credit boom legacy, net credit growth to households is still subdued, but the household debt service remained one of the highest in the EU, as demonstrated by housing costs in disposable income and the debt service ratio. While lending standards have not been visibly tightened by banks, there is already some increase in the debt service-to-income (DSTI) ratio (BoG, 2023b), with Greece recording the highest share of loan-to-value (LTV) ratio exceeding 80 percent among the EU countries (EBA, 2022), although evidence from the joint distribution of risk indicators does not suggest reasons for significant concern (BoG, 2023b).[3] The exposure of banks to the real estate market is below the EU average and less significant compared to the pre-GFC levels.

[2] See IMF (2022) Selected Issues Paper, Enhancing Macroprudential Capital Buffers in Greece, for a discussion on the rationale for the countercyclical capital buffer (CCyB) in Greece.

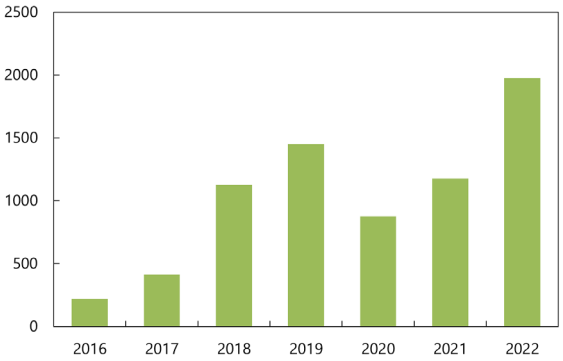
[3] Based on the BoG data, the share of new loan disbursements with an LTV>80% stood at 5.7% in Q2 2023.

## Figure 1. Greece: Real Estate Sector

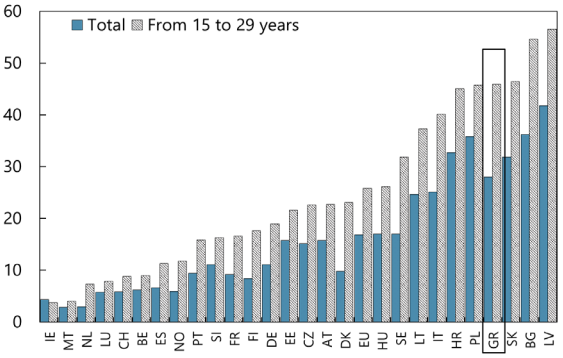
### Residential Prices and Valuation
(Percent, year-on-year, deviations from long-term average)



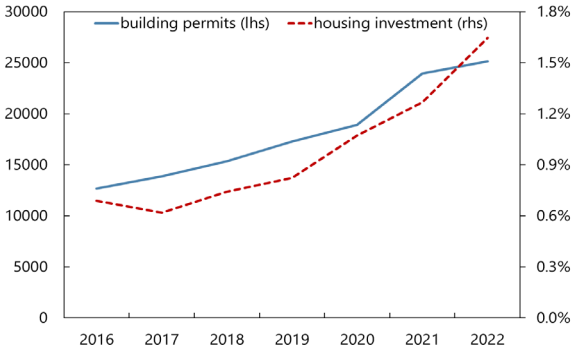

### Net Foreign Direct Investment in Real Estate
(Million euros)




### Overcrowding Rate, 2022
(Percentage)



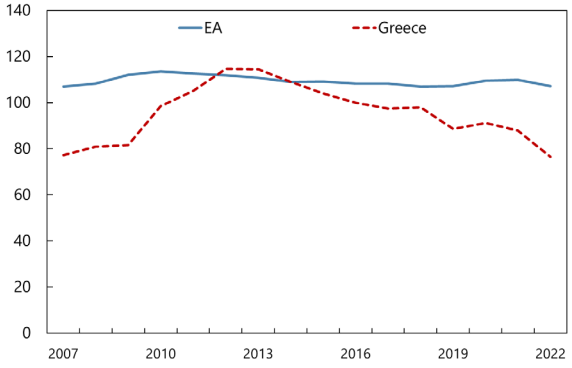

### Housing Investment and Building Permits
(LHS units; RHS percent of GDP)




Sources: OECD; BOG; Eurostat; Haver Analytics; EU-SILC Survey; and IMF staff calculation.

## Figure 2. Greece: Household Sector

### Household Debt to Disposable Income
(Percentage)




### Share of Housing Costs in Disposable Household Income, 2022
(Percentage)

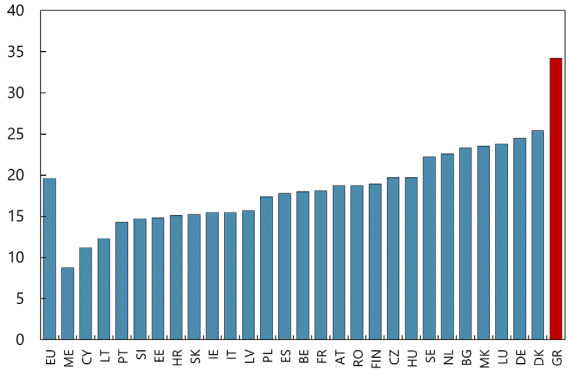
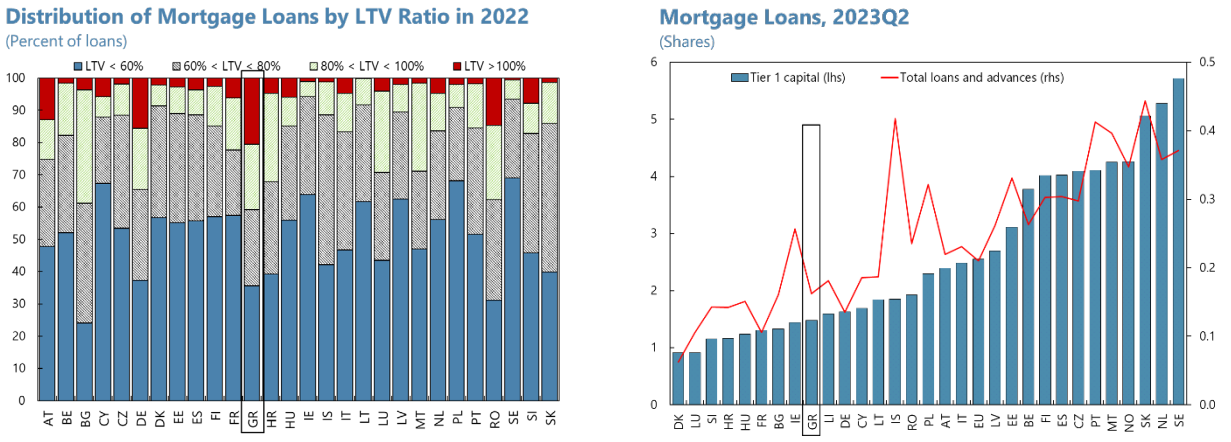


**Figure 2. Greece: Household Sector** (concluded)




Sources: BOG; EU-SILC Survey; EBA (2022); Eurostat; Haver Analytics; and IMF staff calculation.

## C. Macroprudential Policy Options

### Policy Toolkit in Greece

**6. Recognizing growing imbalances in the real estate market, the BoG has recently introduced the necessary legal framework to activate BBMs**. Given the protracted distress period involving a substantial household deleveraging and real estate market correction, there was no policy framework for BBMs in place until 2023.[4] But the BoG has recently identified vulnerabilities in the real estate market as an important source of systemic risk, currently assessing the merits of implementing BBMs in near term (BoG, 2023b). Paving the way to address this risk, the legal framework was amended in 2023, so the BoG now has the power to enact BBMs for financial institutions established and operating in Greece, as well as branches of foreign institutions in Greece, in connection with credit secured by real estate located in Greece. These measures may include caps on ratios related to the credit or the borrower or specific features of the credit. At its full discretion, the BoG may adopt a decision regarding the type of BBMs, the types of credit to which such BBMs apply, where it imposes caps, the ratios or features of credit to which limits apply, as well as the cap percentages, the terms and conditions of implementation of BBMs, and the data and information to be submitted by the financial institutions.

### Modalities and Trade-offs

**7. Income- and collateral-based measures constitute key and complementary elements of the BBM toolkit**. Income-based measures help enhance the resilience of new borrowers through reducing the probability of default (PD) among households thanks to relating loans to the overall debt repayment and/or servicing capacity of households, with the primary instrument defined in

[4] While CBMs in the form of CCoB, O-SII, and CCyB have been implemented in Greece, CCyB has not yet been activated (BoG, 2023b).

terms of caps on the DSTI ratio. Collateral-based measures help shield against house price corrections through containing the loss given default (LGD) on loans granted owing to reducing the unsecured portion of a loan, with the cap on the LTV ratio employed as the most common instrument. Taking into account that income- and collateral-based measures operate through complementary transmission channels, they should be considered being implemented jointly, which would increase borrower resilience to income and interest-rate shocks, limit portfolio loss rates in terms of PDs and LGDs, and ultimately reduce bank defaults given the increased resilience of household loan portfolios over the medium term (ESRB, 2019). Other complementary measures could include *inter alia* maturity limits, loan amortization, risk weights, and targeted CBMs.[5]

**8. When considering BBM activation, it is vital to take into account trade-offs**. BBM caps are typically set weighting the benefits of risk mitigation in the form of excluding or reducing the proportion of riskier loans against the cost of limiting credit intermediation and market access for lower-income borrowers. Ampudia and others (2021) present evidence from a panel VAR framework for the EU countries suggesting that BBMs help contain house prices, with an adverse impact on credit and GDP, consistent with evidence from Cerutti and others (2015) and Araujo and others (2020). These findings are also broadly in line with evidence from Giannoulakis and others (2023) who based on a model combining household- and country-level data for the EU countries confirm a positive impact of BBMs on household resilience, although the authors also point to some reduction in mortgage loan volumes. Georgescu and Vila Martin (2021) examine the impact of BBMs on income and wealth inequality using household-level data for the EU countries, finding only limited distributional effects.

**Other Considerations**

**9. The timing for BBM activation should take into consideration the real estate market cycle and policy lags**. By acting on in the early stages of the real estate cycle, vulnerabilities can be addressed through BBMs when they are still building up, effectively smoothing cyclical swings compared to the counterfactual of late policy response. When the real estate cycle is more mature, a combination of BBMs and CBMs could be considered, with the overarching objective of enhancing resilience, as the former affect only the flow of new lending, while the latter have an impact on the resilience of lenders. Beyond institutional arrangements that may have some impact on implementation, there might also be lags associated with the time needed for a policy to have the desired effects.

**10. BBMs should be designed and calibrated considering the nature of potential vulnerabilities**. Depending on the prevailing level of lending standards and the specific policy objectives, instruments may be calibrated in a binding or nonbinding way, with the former aiming at taming cyclical risks and the latter being suitable when the current lending standards are considered sufficiently prudent, and policymakers are aiming to curb structural vulnerabilities in lenders and borrowers' balance sheets. In addition, depending on the nature of the identified vulnerabilities and

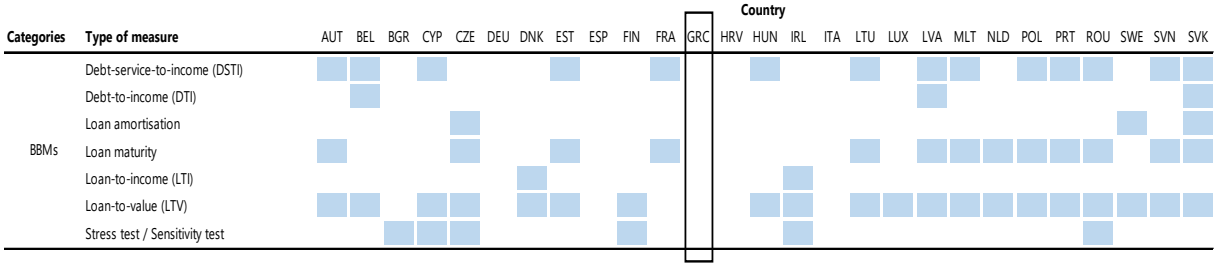
[5] See IMF (2014) and ESRB (2019) for a comprehensive coverage of macroprudential measures.

the policy objectives, the calibration of instruments may be static or dynamic over the cycle. Furthermore, speed limits and exceptions can be used to target specific segments of the borrower population, given that BBMs may have distributional consequences restricting access to the credit market among young households with low wealth, but otherwise good income prospects. Exceptions may be considered to allow a given fraction of the flow of new lending to exceed the macroprudential limits, thus giving banks some flexibility to grant more favorable borrowing conditions to those borrowers considered less risky (Lo Duca and others, 2023).

### Implementation in the EU Countries

**11. BBMs have been very widely implemented in the EU, with the prominent role played by DSTI and LTV caps**. Following the ESRB recommendation on BBMs, the vast majority of the EU countries have activated them in some form, typically more than two instruments and predominantly covering both income- and collateral-based dimensions. Caps on DSTI and LTV are the most commonly used instruments among the EU countries, with 14 countries having implemented DSTI and 20 countries LTV. Greece is one of the very few countries that have not yet implemented any BBMs, which is in contrast with countries such as Cyprus, Ireland, and Portugal that introduced BBMs much earlier despite being subject to the similar private sector deleveraging.

**Figure 3. EU: Macroprudential Borrower-Based Measures**




Source: ESRB; and IMF staff estimates.

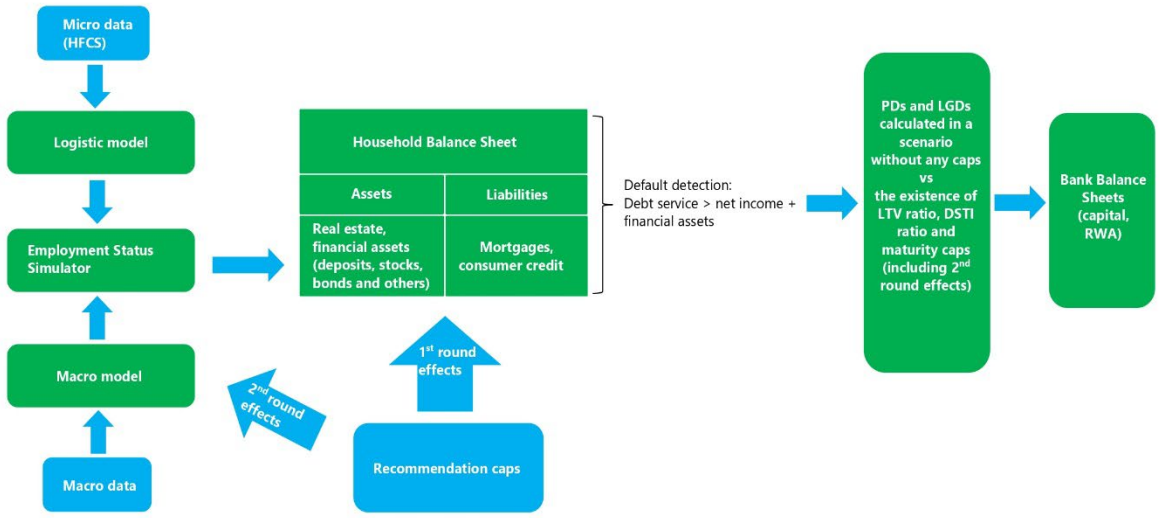
## D. Policy Calibration

### Calibration Framework

**We employ an established quantitative framework combining micro- and macro-economic dimensions to assess the impact of BBMs**. Following Gross and Poblacion (2016, 2017) and subsequent refinements by Giannoulakis and others (2023), we use the framework that quantifies the extent to which BBMs enhance the resilience of households and banks. The framework combines micro-level data on key household financial and sociodemographic characteristics in Greece from the Household Finance and Consumption Survey (HFCS) with macro-level quarterly data covering key macroeconomic and financial variables for Greece from the ECB and national sources (Appendix 1). The model captures the dynamics of household debt service and consumption expenditure along with labor income and unemployment benefits, depending on household members' simulated

employment status. The primary outputs of the model are individual households' simulated PDs, LGDs, and loss rates (LRs), which are subsequently linked to bank mortgage portfolios to assess their capital impact. The model also accounts for macro-financial feedback of policies, which result from their drag on credit demand. The framework has been extensively used for assessing impact of the BBMs in advanced economies, with examples including Slovakia by Jurca and others (2020), Portugal by Neugebauer and others (2021), and USA and EA by Gross and others (2022). The schematic presenting the key elements of the framework is below.

**Figure 4. Greece: Key Elements of Calibration Framework**




Source: Adapted from Gross and others (2017) and Neugebauer and others (2021).

**12. The framework allows to assess the impact of BBMs on the resilience of households and banks**. In the first step, the aim is to assess by how much DSTI and LTV caps are able to reduce household PDs and LGDs. Furthermore, additional insights are gained through assessing how much of the outstanding mortgage debt would be crowded out as a function of caps and what is the mapping between LTV and the loss rate-equivalent DSTI caps. In the second step, household risk parameters under no policy scenario are compared with the respective post-policy distributions for the DSTI and LTV caps consistent with the mapping. Results are presented for the implementation of individual macroprudential limits to LTV and DSTI separately, as well as for the joint implementation of the limits. The first- and second-round effects are considered, with the former representing an impact of given BBM setting on PDs, LGDs, and LRs and the latter adding an impact of negative loan demand shock on PDs, LGDs, and LRs. In the final step, the model computes an impact of the given BBMs on the capital adequacy ratio of banks through reducing loan losses from mortgage credit portfolio and lower risk weights resulting from lower risk parameters.

## Impact on Household Resilience

**13. The analysis suggests important trade-offs for the BBM activation**. The evidence shows that the initial PD starts to decline sharply from a DSTI cap at around 90 percent, through an already sizeable impact for the cap at 50 percent, reaching its maximum level at the left end of the DSTI cap, while the impact of LTV caps on PDs is estimated to be smaller. The simulation also demonstrates a significant impact of LTV caps on LGDs that are estimated to decline sharply from an LTV cap at around 90 percent, although DSTI caps do not seem to significantly affect LGDs. The mortgage volume reduction associated with the crowding out effect of imposing caps suggests a stronger impact of LTV caps compared to the loss rate equivalent DSTI caps, which implies that for a smaller share of the population DSTI caps would have been binding to achieve the same loss rate as the corresponding LTV cap. The estimated mapping of the DSTI cap to the LTV cap suggests that for an LTV cap at 85 percent, the equivalent DSTI cap would equal around 40 percent. DSTI caps seem to have a stronger potential to reduce PDs, while LTV caps have a stronger bearing on LGDs.

**Figure 5. Greece: DSTI and LTV Cap Impact Assessment**

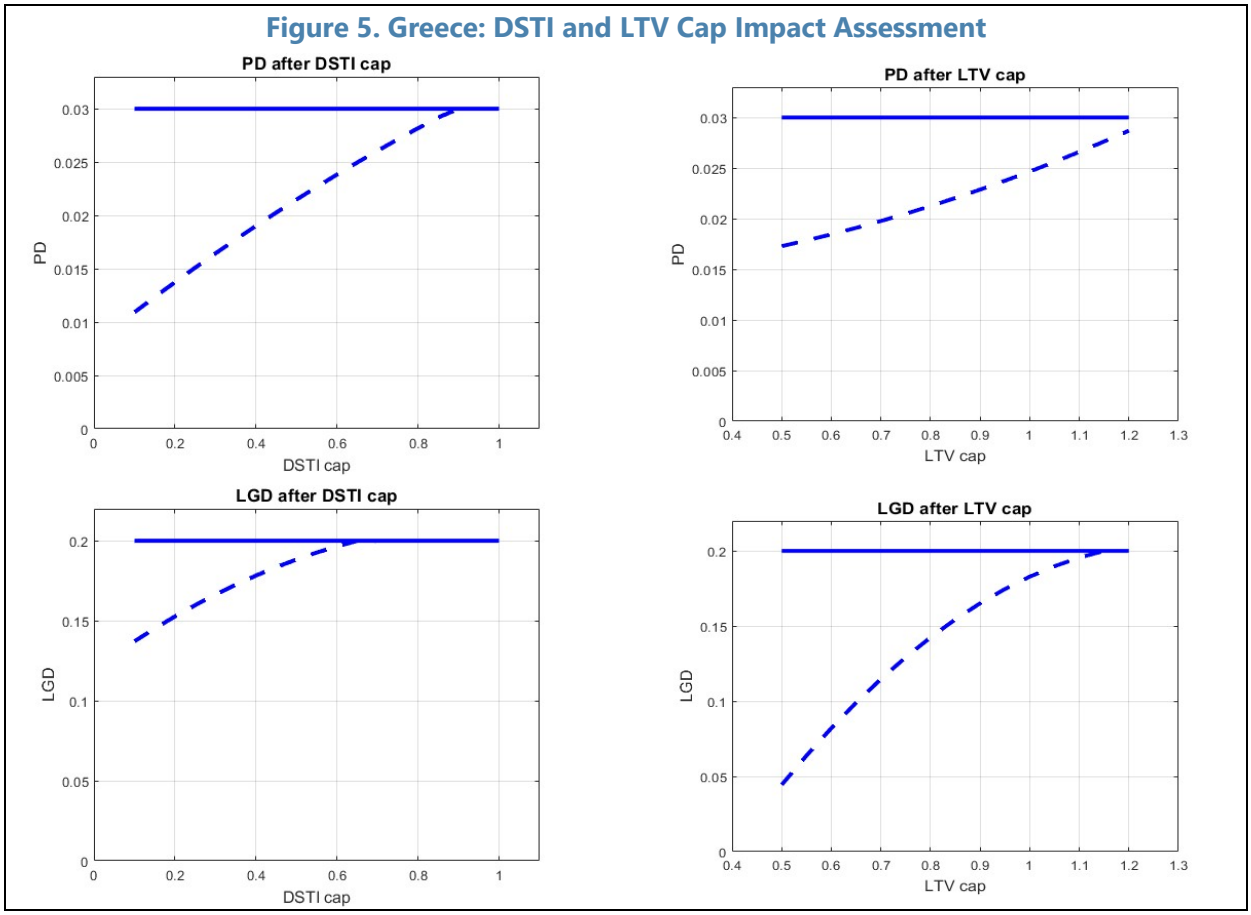
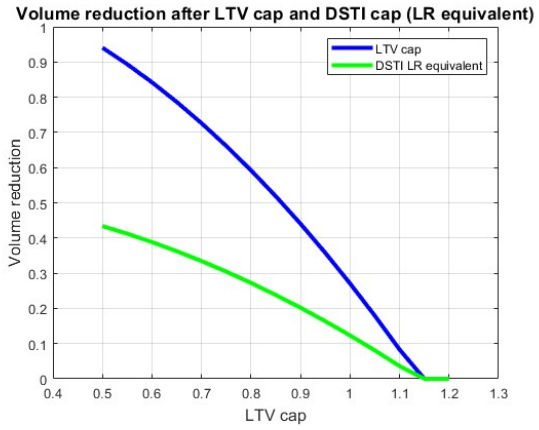
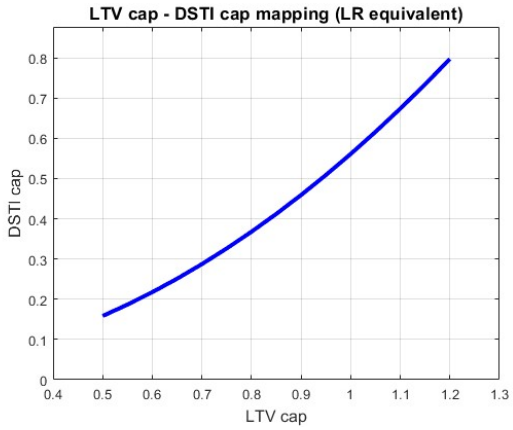


**Figure 5. Greece: DSTI and LTV Cap Impact Assessment** (concluded)

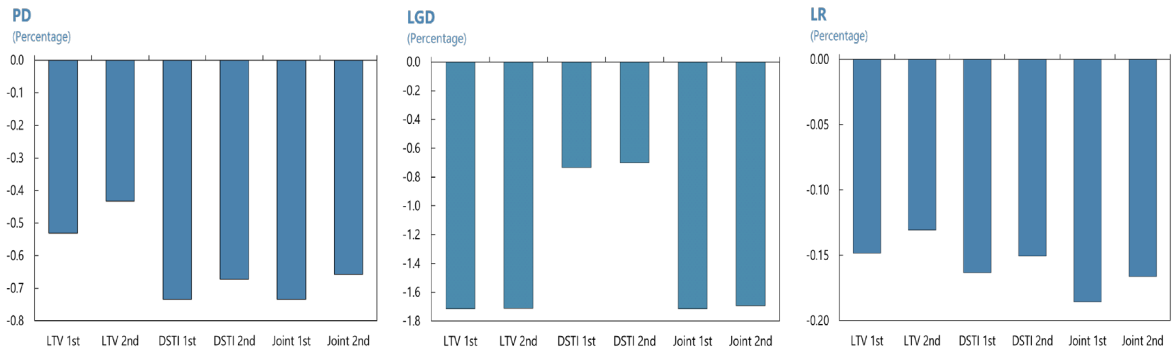



Sources: HFCS and IMF staff calculations.

**14. BBMs are estimated to enhance household resilience, with stronger effects for the joint implementation of DSTI and LTV caps**. Building on the estimated mapping between DSTI and LTV caps and taking into account the implemented calibration of these caps in other European countries, DSTI is set to 40 percent and LTV to 85 percent.[6] The evidence suggests that DSTI caps lower PDs more compared to LTV, while LTV caps reduce LGDs more than for DSTI caps. These results are consistent with the priors suggesting DSTI caps are related to such flow variables as income and expense, while LTV caps are related to a stock ratio. The overall impact in terms of LRs is estimated to be sizeable and higher for DSTI caps compared to LTV caps, with only relatively limited second-round effects taking into account a negative loan demand shock. The joint implementation of DSTI and LTV caps demonstrates a stronger impact in terms of increasing borrower resilience when compared to individual limits. This can partly be attributed to the complementarities between income-based measures acting primarily via the PD channel and collateral-based measures acting primarily via the LGD channel and in line with evidence from Gross and Poblacion (2017).

**Figure 6. Greece: Impact of DSTI and LTV Caps on Households**



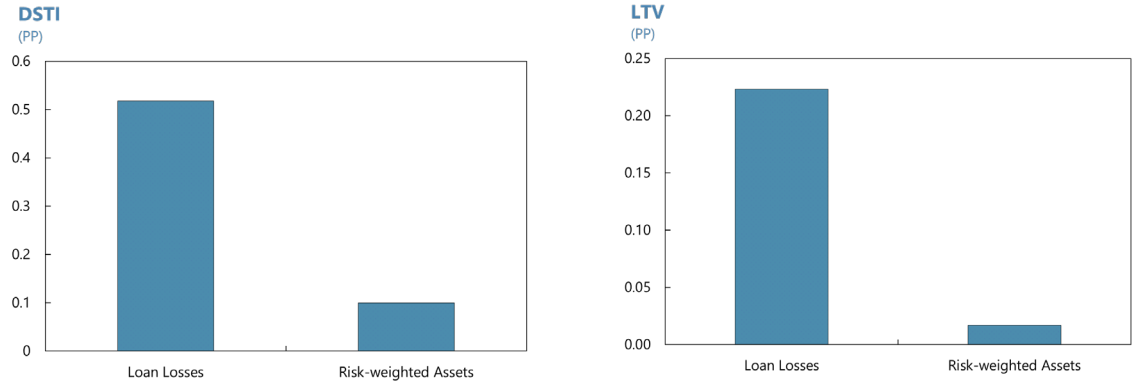

Sources: HFCS and IMF staff calculations.
Notes: Impact estimated based on the calibration assuming DSTI = 40 and LTV = 85

[6] Results for an alternative calibration are presented in Appendix 2.

### Impact on Bank Resilience

**15. BBMs are found to have a positive impact on bank capital**. Compared to the starting point for banking system balance sheets, there is an estimated positive impact on CET1 ratios for policy limits, with stronger effect for DSTI caps compared to LTV caps. The estimated impact seems relatively sizeable, given that it reflects only the mortgage loan portfolio. Decomposing the impact into the numerator and denominator effects, the estimated reduced loan losses from mortgage credit portfolio outweigh the lower risk weights owing to lower PDs and LGDs.

**Figure 7. Greece: Impact of DSTI and LTV Caps on Bank Capital**




Sources: HFCS and IMF staff calculations.

## E. Conclusions and Policy Implications

**16. There are emerging vulnerabilities in the real estate and household sectors requiring close monitoring**. Greece experienced a protracted distress period involving a substantial household deleveraging and ensuing real estate market correction. But house prices have increased significantly since its trough in 2017, supported by strong employment and real disposable income growth, as well as demand from nonresidents and lingering structural imbalances in the real estate sector. Although there was a significant supply response, various metrics suggest moderate overvaluation. While the household sector leverage is generally low, the household debt service remained high, pointing to growing vulnerabilities in the sector.

**17. Enhancing the macroprudential policy toolkit with BBMs would help increase resilience of households and banks, contributing to the systemic risk reduction**. Recognizing growing imbalances in the real estate market, the authorities have recently introduced the necessary legal framework for setting BBMs, paving the way to activating both income- and collateral-based measures. Employing an established quantitative framework combining micro- and macro-economic dimensions based on Greek data, simulations show that BBMs are estimated to enhance household resilience, confirming some complementarities between DSTI and LTV caps. Both caps lower PDs and LGDs, with stronger effects of LTV on LGD and DSTI effects on PD. The impact of DSTI caps is stronger than LTV caps, which come at a cost of lower lending. The joint implementation of DSTI and LTV caps demonstrates a stronger impact on borrower resilience compared to individual caps. Building on increased household resilience, BBMs are also found to increase over time bank

resilience, with stronger effects related to DSTI caps compared to LTV caps. Caps could initially be set at less binding levels and gradually tightened over time.

# Appendix I. Data Description

## *Household Data*

| | | Model Variable | | Variable Code in the HFCS + Transformation |
|---|---|---|---|---|
| | Assets | H | Current value of house | DA1110 |
| | | TFA | Total financial assets (incl. cash, stocks, bonds, pensions, life insurance) | DA2100 - DA2104 (value of business) - DA2107 (money owed to others) |
| | | B | Current market value of bonds | DA2103 |
| | | S | Current market value of stocks | DA2105 |
| | Liabilities | $D^m$ | Outstanding balance of mortgage debt | DL1100 |
| | | $D^{NM}$ | Outstanding balance of non-mortgage debt | DL1200 |
| | Income Flows | I | Household income total, quarterly, gross of tax (used only for calculation of DSTI and DTI ratios for MPRU policy exp.; labor income, pensions, and unemployment benefit are used and modeled at HH member-level) | DI2000 / 4 |
| | | RI | Rental income, quarterly | HG0310 / 4 |
| | | OI | Other regular income, quarterly, e.g. child benefit, alimony, etc. | (HG0110 + HG0210) / 4 |
| | Expense Flows | $A = A^M + A^{NM}$ | Annuity for mortgage debt, quarterly | DL2100 * 3 |
| | | | Annuity for non-mortgage debt, quarterly | DL2200 * 3 |
| | | OE | Rental expense, quarterly (needed only if focus is on HHs who rent) | HB2300 * 3 |
| | | E | Living expense, excl. annuities and rent, quarterly | DOCOGOOD / 4 |
| | Other | HH_ID | Household ID | SA0010 (made unique across countries) |
| | | HW | Household weight | HW0010 |
| | | HH_RES | Country of residence | SA0100 |
| | | Myear | Year of 1st mortgage origination; for MPRU exp. Only | HB1301 |
| | | MiniDur | Duration of 1st mortgage at origination in years; for MPRU exp. only | HB1601 |
| | | DType | Rate type of total debt (variable vs. fixed) | DL1110{a,b,c}i |
| | | $i^M$ | Current interest rate on mortgage debt; if not reported at HH-level, then filled with country-aggregate consumer debt interest rate | W.A. from mortgages outstanding (HB170x) and their interest rates (HB190x) |
| | | $i^D$ | Current interest rate on total debt; if not reported at HH level, then filled with country-aggregate consumer debt interest rate | Total absolute annual interest flow (DI1412) over total current debt (DL1000) |
| | | $M^{RES}$ | Synthetic residual duration of total debt in months (needed for variable rate loans only) | ceil(log(4*A./(4*A-$i^D$.*($D^M$+$D^{NM}$))./log((($i^D$./12)+1)) |
| | | Etol | Living expenses (excl. Annuities and rent) as share of gross income | E/I |
| HM-Level | Income Flows | $INC^E$ | Labor income (gross of tax) from employment or self□er | (PG0110 + PG 0210 + PG0310 + PG0410 ) / 4 |
| | | $INC^U$ | Unemployment benefit, net of tax, quarterly | PG0510 / 4 |
| | Other | HM_ID | Household member ID | ID |
| | | HM_HH_map | Household members' household IDs | SA0010 |
| | | HM_RES | Country of residence | SA0100 |
| | | LAB | Labor status; see separate table for code mapping | PE0100a |
| | | MAR | Marital status; see separate table for code mapping | PA0100 |
| | | EDU | Level of education; see separate table for code mapping | PA0200 |
| | | GEN | Gender | RA0200 |
| | | AGE | Age | RA0300 |
| | | DF | Nationality / Domestic-foreign indicator | Generated from country of birth |

### *Macroeconomic Data*

| Variable | Comments | Source |
|---|---|---|
| URX | Unemployment rate anchor point for the last year (2017) | ECB Statistical Data Warehouse |
| IR | Short-term interest rate level anchor point for the last year | ECB Statistical Data Warehouse |
| HPG | Annual house price growth in the last year (log difference-based) | ECB Statistical Data Warehouse |
| SPG | Annual stock price growth in the last year (log difference-based) | ECB Statistical Data Warehouse |
| CPG | Annual compensation per employee growth in the last year (log difference -based) | ECB Statistical Data Warehouse |
| DEPR | Deposit rate in the last sample year | ECB MIR |

### *Banking Data*

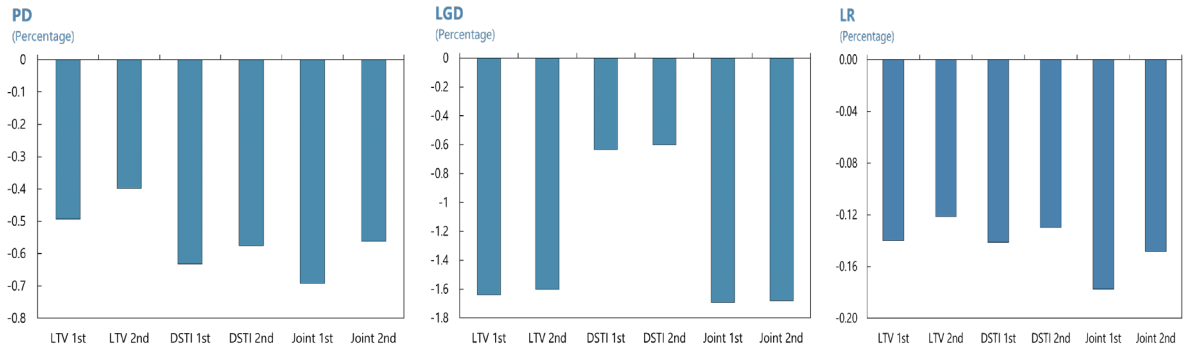
| Input Parameters | Explanation | Source |
|---|---|---|
| RWA Total | Risk Weighted Assets | ECB Statistical Data Warehouse |
| CET1 Total | Core Equity Tier 1 Capital | ECB Statistical Data Warehouse |
| IRB (IRB+STA) | Share of IM mortgages in total mortgage stock | EBA |
| RW on STA mortgage portfolio | Implied by regulation | BCBS |
| Mortgage loan stock – performing | Performing mortgage loans | ECB Statistical Data Warehouse |
| Mortgage loan stock – nonperforming | Non-performing mortgage loans | ECB Statistical Data Warehouse |
| PiT PD | Mortgage PD anchor point for the last sample year (2017) | EBA Risk Dashboard |
| PiT LGD | Mortgage LGD anchor point for the last sample year (2017) | EBA Risk Dashboard |
| TTC PD of mortgages | Through the cycle PD – estimated PD for the upturn of the cycle | EBA |
| DT LGD of mortgages | Downturn PD – estimate for the downturn of the cycle | EBA |
| Mortgage loan interest rates | | ECB Statistical Data Warehouse |

# Appendix II. Alternative Calibrations

***Alternative Calibration***

DSTI = 45 percent and LTV = 90 percent

**Appendix II. Figure 1. Greece: Impact of DSTI and LTV Caps on Households**




Sources: HFCS and IMF staff calculations.
Notes: Impact estimated based on the calibration assuming DSTI = 45 and LTV = 90

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# RECENT TRENDS OF INFORMALITY IN GREECE – EVIDENCE FROM SUBNATIONAL DATA[1]

*This paper explores the evolution of informality in Greece as it is widely considered one of the major structural impediments to fiscal capacity and sustainable growth. It finds that informality has dropped significantly in Greece in recent years, although there were temporary increases during the sovereign debt crisis and the COVID-19 pandemic. Lower informality is also found to be associated with higher subsequent per capita GDP growth and higher tax revenue. Moreover, Greece's significant recent progress in digitalization appears to have helped reduce informality. There remains scope to further reduce informality by accelerating digitalization and the ongoing pro-growth structural reforms.*

## A. Introduction

**1. High levels of informality in Greece have been understood as a major structural impediment and a major target of reforms since the sovereign debt crisis.** Widespread informality was considered to have impeded sustainable growth and fiscal capacity (e.g., McKinsey & Company (2012) and Oxfam (2013)). Therefore, the subsequent structural reforms also focused heavily on measures aimed at reducing informality and the associated tax evasion (e.g., European Commission (EC) (2014) and IMF (2017)). While the reform progress was more mixed in the previous years (Botman and Kalavrezou (2019)), more positive results have been achieved over time, including in labor market flexibility and the business environment, with improved implementation efforts by the authorities (EC(2023a) and OECD(2023)).

**2. This paper uses some big data sources and other sub-national data in addition to conventional data used in the literature to analyze how informality has evolved in recent years to inform relevant policy discussions.** Informality, or informal economy, discussed in this paper refers to economic activities not covered or insufficiently covered in formal arrangements. As in Alexander and others (2021), informality "comprises production of informal sector units, production of goods for own final use, production of domestic workers, and production generated by informal employment in formal enterprises." Given the inherent difficulty to measure informality that is not covered in formal statistics and encounters reporting bias in surveys, we explore using conditionally independent indicators, including some big data sources, including satellite nightlight and google search, at the subnational level and the Multiple Indicators Multiple Causes (MIMIC) approach. In addition, we explore how digitalization efforts affect informality developments and draw on other recent studies to discuss policy implications.

[1] Prepared By Larry Qiang Cui and Jiaxiong Yao, with research assistance by Shiqing Hua and Katherine Dai. This paper benefited from valuable comments from the Bank of Greece and the Ministry of Finance.

## B. Literature Review

**3. There is a large literature on estimating informality including for EU countries, albeit with varied definitions.** In the literature, informality is known in varied names with overlapping coverages, such as "shadow economy" or "grey economy." Some studies rely on micro survey data, while others use model estimations. For example, Elgin and Schneider (2016) studied levels and driving forces of informality in 38 OECD countries using both DGE and MIMIC approaches. Elgin and others (2019) used a large dataset to document that the share of the informal economy for advanced economies has declined to an average of 17 percent in 2016. In another cross-country study, Hu and Yao (2022) find that using satellite nightlight data, which are independent to economic statistics and survey data, can improve the estimates of true GDP per capita.

**4. Several different approaches have been explored in estimating the size of the informal economy in Greece.** Artavanis and others (2016) used micro data on household credits from a Greek bank and estimated that about 43-45 percent of self-employment income was not reported and thus not taxed. Also, Dellas and others (2017) at the Bank of Greece used a DSGE model and the actual fiscal consolidation measures to evaluate the role of the informal economy during 2010-15. They find that informality increased substantially from 25 percent of GDP to between 35 and 40 percent of GDP, which in turn affected the results of fiscal measures including missed revenue targets. In addition, Kelmanson and others (2019) estimated informality trend for European countries using MIMIC and reported that informality in Greece declined from 32 percent of GDP in 2009 to 30 percent of GDP in 2016. More recently, Schneider and Asllani (2022) provided updated estimates on the size of informality in the EU, showing that informality in Greece declined continuously from about 24 percent in 2013 to 19 percent in 2019 but edged up in 2020 and 2022. However, few studies have used sub-national data to study informality in Greece, while recent progress in available big data has offer better support to this approach as adopted in our paper.

**5. Drawing on the recent literature, this paper adopts the MIMIC approach with improved data and estimation method.** Medina and Schneider (2018) evaluated a range of methods used in estimating informality using data for 158 countries. They found that MIMIC method has advantages in implementation and provides plausible results as compared to other methods (e.g., micro survey, national account discrepancy approach, transaction approach, and currency demand approach), and using nightlight intensity data can further mitigate potential endogeneity bias. Therefore, we chose MIMIC in the estimation, added satellite nightlight and google searches to conventional data sources, and further improved the estimation method.

## C. Methodology and Data

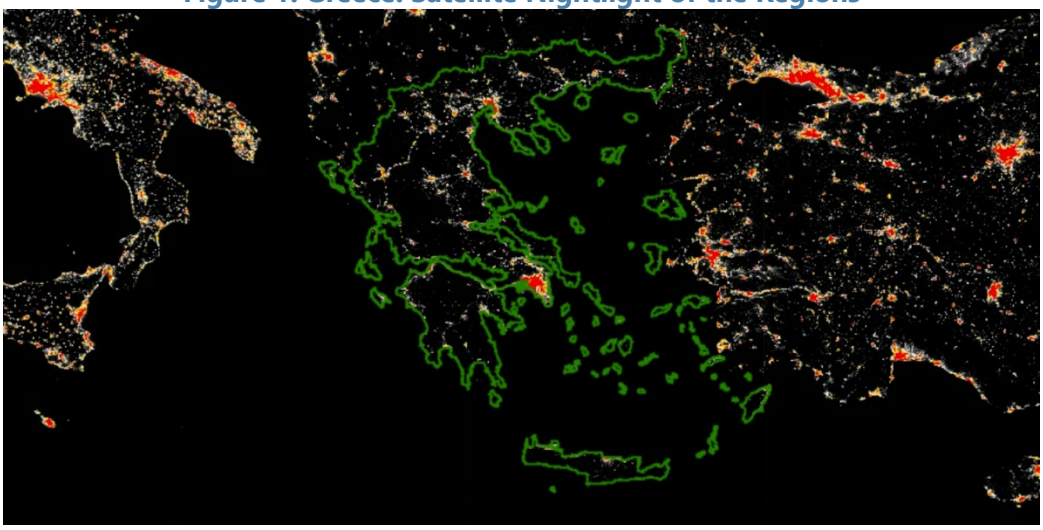
**6. The MIMIC method links multiple observable indicators to multiple observable causes of the informal economy through a latent variable (Annex I).** The latent variable is an index of the informal economy that can be used to calculate the size of the informal economy through variable transformation and calibration. First, it estimates the latent informality index by regression with restrictions through maximum-likelihood estimation. Next, World Bank (2018) Enterprise Survey

for Greece is used to calibrate the index to the survey data and relate the informality index to formal GDP statistics.

**7. In addition to observable indicators used in the literature, we add satellite nightlight data and google search data at the subnational level for 2012–2021.** These observable subnational data are in quarterly frequency and are more independent from formal national statistics or self-reported survey data to help mitigate potential biases. The use of subnational data also allows the analysis to focus on the variations in a shared institutional environment.

- *Satellite nighttime lights*. Satellite-recorded nighttime lights have been shown to be highly correlated with economic activity (see, for example, Henderson and others (2012), Hu and Yao (2022), Beyer and others (2022)). Following Beyer and others (2022), this paper uses the nighttime data from the Visible Infrared Imaging Radiometer Suite (VIIRS) Day on board of the latest generation of earth observation satellite. The sum of nighttime light intensity (radiance) within each region is used as a proxy for overall economic activity in that region (see Figure 1 for a snapshot illustration).

**Figure 1. Greece: Satellite Nightlight of the Regions**



Sources: The Earth Observations Group, Colorado School of Mines and authors' calculations.

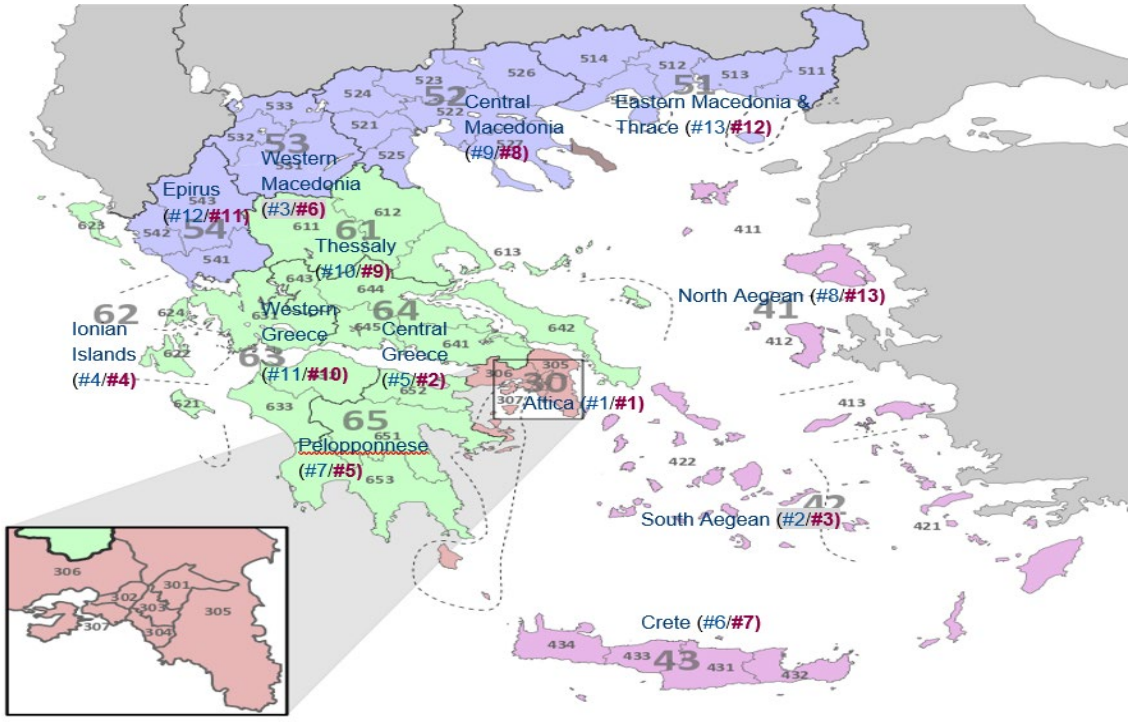
- *Google search*. Given the importance of tourism in Greece, google search data are also used as an independent source to proxy true tourism-related activities. Narita and Yin (2018) and Hu and others (2023) have shown that the search volume of a country name can be a useful indicator of economic activity of that country. This paper uses the search volume of the name of a subnational region as a proxy of economic activity in that region.

- *Other conventional variables in the literature including labor participation rate and GDP*. Labor participation rate and GDP are from Eurostat at NUTS 2 subnational level. Notice that due to population aging, the labor participation rate of the entire population could have a different trend from that of population aged 20-64. As the latter is most likely to participate in the

informal economy, the activity rates for population aged 20-64 are used. Both labor participation rate and GDP are transformed into first differences as typically used in the MIMIC literature.

**8. On causes, we used the conventional variables to reflect the underlying reasons that give rise to the informal economy.** At the sub-national level, we include Eurostat data on agriculture employment as a share of total employment, self-employment as a share of total employment, unemployment rate, lagged income per capita, tourist arrivals as a share of total population, as well as education attainment. For education attainment, the share of population aged 25-64 with less than primary, primary, and lower secondary education is used, as less skilled labor tends to participate in the informal sector. At the national level, we also used macro variables related to the role of fiscal policy, trade, and governance: Value Added Tax (VAT) gap, tax as percent of GDP, trade openness, government consumption as percent of GDP, and World Bank governance indicators.

**Figure 2. Greece: Regions and Their Ranking in Per Capita GDP**
(Ranked by 2015/2021 per capita GDP)




Sources: Eurostat, Greek authorities, and IMF staff calculations.

**9. For calibration, we used a World Bank Enterprise Survey for Greece in 2018, which is the most recent and publicly available survey with relevant information on informality.** The survey classifies firms at NUTS 1 subnational level. As such, the size of the informal economy at each NUTS 1 region is calculated. Each NUTS 2 region is assumed to have the same level of informality as the NUTS 1 region that they belong to. The key source data are based on two questions closely related to the size of the informal economy:

- "Does this establishment compete against unregistered or informal firms?"
- "What is the number of permanent, full-time employees at the end of last fiscal year?"

The answers to these two questions are denoted by e and l, respectively, with e=0 indicating no competition with unregistered or informal firms and e=1 indicating competition with unregistered or informal firms. The number of employees in firms that are competing with informal firms in a region can then be computed as $\sum e_{kt} l_{kt}$, where k is a firm index in a region of interest. Assuming that each formal firm that competes with unregistered or informal firms has exactly one competitor with the same number of employees, one can calculate the size of the informal economy as follows:

$$z_t = \frac{\sum e_{kt} l_{kt}}{\sum e_{kt} l_{kt} + \sum l_{kt}}.$$

The key stylized facts based on the 2018 enterprise survey are summarized below:

**Text Table 1. Greece: Implied Informality Share from a Firm Survey**
(percent of GDP)

| By Region | | By Sector | |
|---|---|---|---|
| Northern Greece | 15% | Food | 27% |
| Central Greece | 24% | Fabricated Metal Products | 17% |
| Attica | 20% | Other Manufacturing | 13% |
| Aegean Islands | 25% | Retail | 29% |
| | | Other Services | 19% |

Sources: The World Bank Enterprise Survey (2018) and authors' calculations.

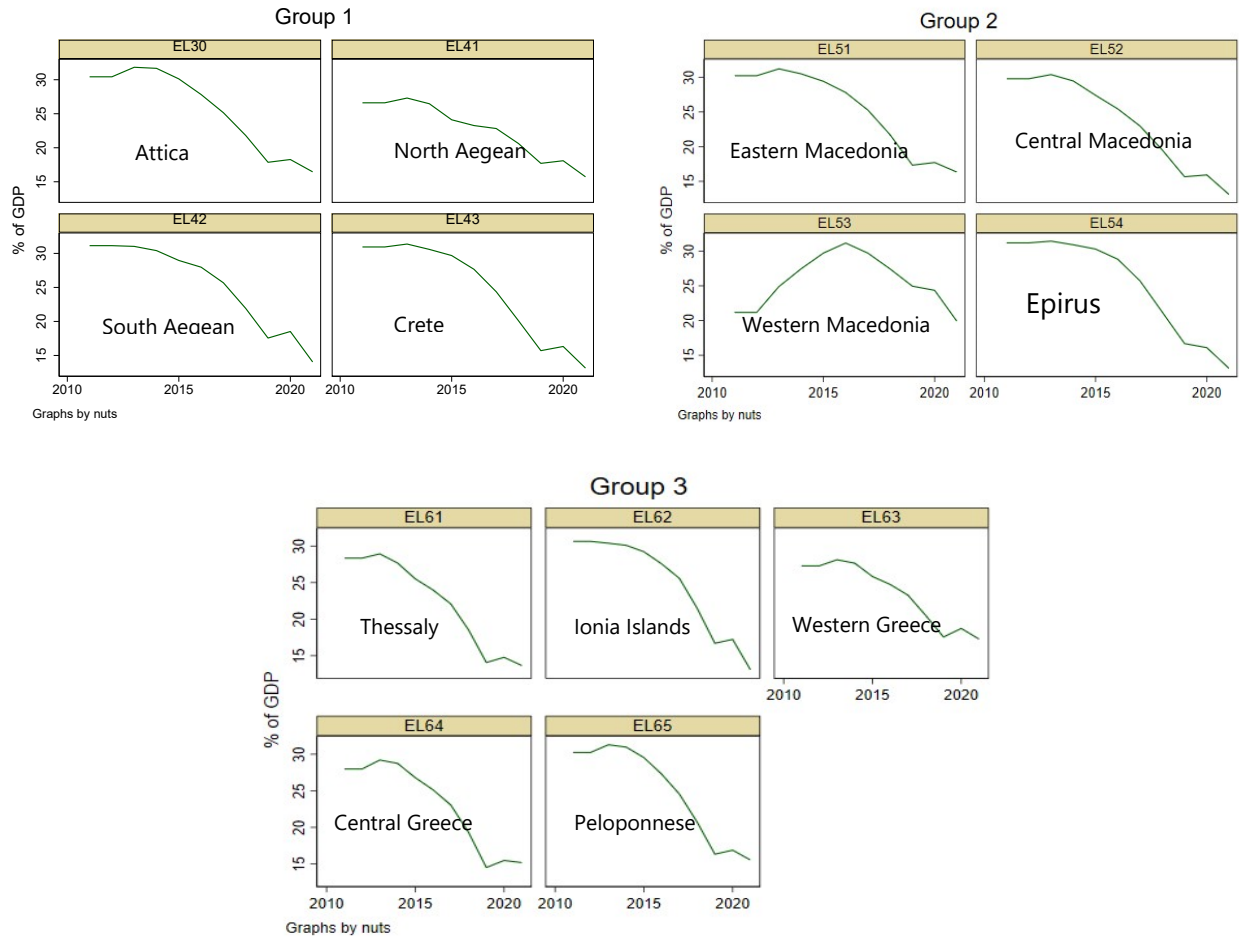
## D. Main Findings

**10. The estimates show that informality has dropped significantly in all regions in the past decade, notwithstanding some brief increases around 2013-15 and 2020 (Figure 3).** During the sovereign debt crisis periods, most regions experienced increased informality by an average of 0.6 percentage point for informality to peak at about 30 percent of GDP at the national level. The results are consistent with earlier findings by Dellas and others (2017), although their estimated increase was larger.[2] Our informality level estimates for this period are more in line with Kelmanson and others (2019) and Schneider and Asllani (2022). The significant increase can be attributed to the severe recession, worsened tax incentives from significant fiscal tightening, and a further weakening of the payment culture with decreased trust in government (Botman and Kalavrezou (2019) and Oxfam (2013)). In comparison, most regions had relatively small increases in informality during the peak pandemic year of 2020 and continued declines in 2021. These increases could be attributed to slower output declines in the informal sector than in the formal sector that is less flexible and more vulnerable to pandemic-related disruptions, similar to what was reported in Elgin and others (2022) and Schneider and Asllani (2022). However, significant government support in Greece during the

[2] Hondroyannis and Papaoikonomou (2017) and IOBE(2018) noted that Greece imposed capital controls that led to a significant increase in card and digital payments that reduced informal payments. To the extent that this presented a structural break, the estimation calibrated using 2018 firm survey data could underestimate the earlier increases in informality during the crisis period.

pandemic likely cushioned the impact and thus moderated the increase in informality compared to previous recessions. In addition, there are also significant variations in the size of informality declines among the regions, ranging from 5 percent of GDP (Western Macedonia) to 18 percent of GDP (Crete). In general, the drops are more significant at above 15 percent of GDP in Attica and the island regions (e.g., Crete and Ionia Islands). In contrast, the more inland region of Western Macedonia experienced higher increases in informality around the sovereign crisis episode followed by a more moderate decline. Similarly, Western Greece saw a smaller decline at about 10 percent of GDP. While the progress in digitalization could explain some of the differences, future research is needed to better understand the drivers of the subnational variations.

**Figure 3. Greece: Informality Trend by Greek Regions**




Sources: Eurostat and IMF staff estimates.

**11. Also, the estimated reductions in informality are associated with positive economic benefits, including lower tax revenue loss and higher subsequent per capita GDP growth.** At the national level, the aggregate informality, weighted by regional gross value added, recorded a decline from a peak of about 30 percent of GDP in 2013 to a low of about 16 percent of GDP in 2021 (Figure 4). Using the buoyancy of the total tax revenue (direct, indirect taxes and social security contributions) to GDP in these years, such a decline in informality is associated with a gain in tax

revenue by about 4 percentage points of GDP.[3] While this estimate is more of a potential tax increase, its magnitude is broadly consistent with recent reports on improved tax collections in Greece. For example, EC (2015 and 2023c) find that Greece's Value Added Tax gap has decreased by over 16 percentage point of its tax base between 2013 and 2021, or about 2 percentage points of GDP. In addition, the correlation of changes in informality and subsequent per capita GDP growth shows that lower informality is associated with higher subsequent growth, also highlighting the output benefits (Figure 5).

**Figure 4. Greece: Estimated National Informality and Tax Revenue Loss**
(percent of GDP; weighted by gross value added)

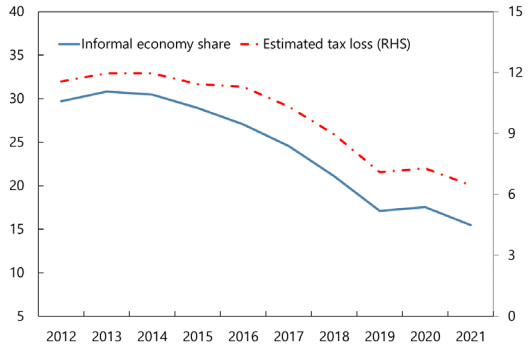
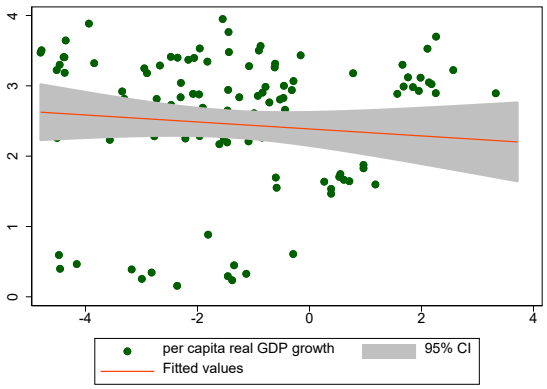



**Figure 5. Greece: Changes in Informality and Subsequent Per Capita GDP Growth**
(percent change)




Sources: Eurostat, Greek Authorities, and IMF staff estimates.

**12. Furthermore, regional-level correlations show that digital infrastructure and its usages have a strong impact on informality in Greece.** Better digitalization indicators show consistent negative correlations with the share of the informal economy at the regional level. First, a 10-percentage point increase in internet access is on average associated with a reduction of informality by about 3 percentage point (Figure 6). Second, a 10-percentage point reduction in the share of residents who have never used internet is associated with a reduction in informality by about 4 percentage points (Figure 7). Third, a 10percentage point increase in the share of residents who used online purchase is associated with a reduction in informality by about 4 percentage points. This is consistent with earlier findings that digital payments reduced informality and tax evasion (IOBE(2018); Hondroyannis and Papaoikonomou (2017)). Fourth, a 10-percentage point increase in the share of residents who used digital public services online purchase is associated with a reduction in informality by about 3 percentage points. While noting the limits in correlation analysis, these results taken together do suggest positive effects of digital infrastructure expansion, digital training, and digital public services. The results also corroborate other recent reports that pointed out digitalization as a major factor that helped reduce informality in Greece. OECD (2023) pointed out

[3] Given the lack of regional data on tax collections, the tax loss estimate is based on national level tax collection and buoyancy in the respective years.

that increased digital transactions raised tax compliance in Greece. While starting from a relatively low level, Greece did make strong progress in digitalization in recent years (EC (2023b), Jaumotte and others (2023)), which in turn likely contributed to the significant reduction in informality.

**Figure 6. Greece: Informality and Internet Access** (percent)

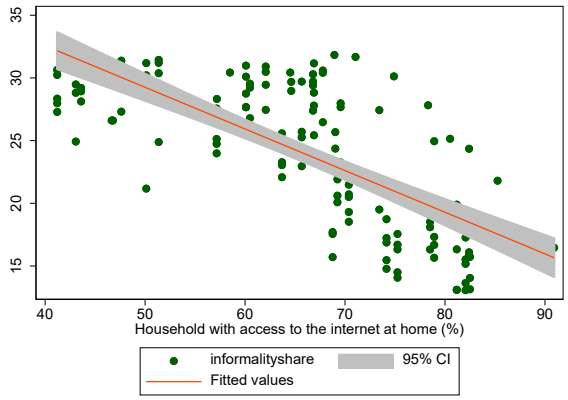



**Figure 7. Greece: Informality and Internet Usage** (percent)

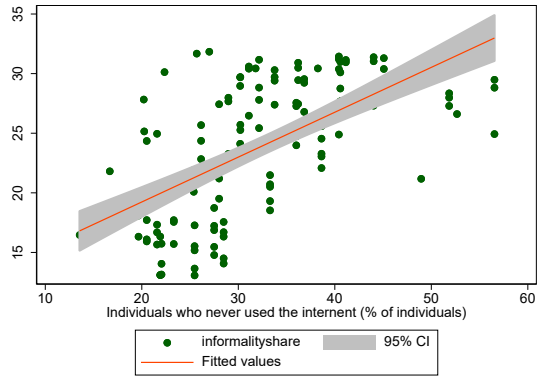



**Figure 8. Greece: Informality and Online Purchases** (percent)

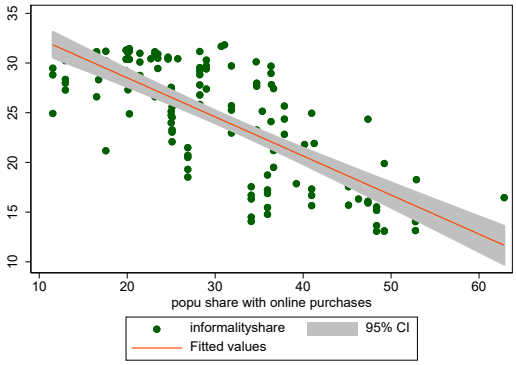
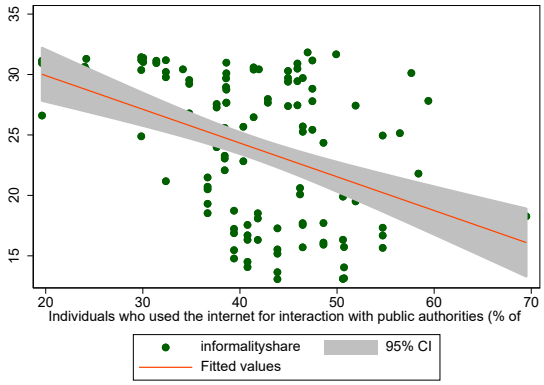



**Figure 9. Greece: Informality and Digital Public Services** (percent)




Sources: Greece authorities, Eurostat, and IMF staff estimates.

**13. Our study presents a first attempt of using sub-national data and big data in estimating the size of informality in Greece, but several caveats should be noted including for future research.** First, if the relations between the variables (including satellite nightlight intensity or google search) and formal and informal economies activities show significantly diverging trend over time, such effects are not well controlled in the estimation. Future research with better calibration using more available data on Greece firm surveys, for example, could refine the estimation. Second, the analysis is also constrained by the lack of availability of more relevant subnational data, such as non-cash transactions, to establish tighter link with regional economic activities. Third, the impact of the social structure of the Greek regions could also have strong effects on informality and requires future research outside of the scope of this paper.

## E. Policy Discussions

**14. The significant decline in informality in recent years benefits from several policy factors.** The tightened regulation and enforcement against financial crimes and tax evasion in Greece likely contributed to reducing informality EC (2023a), Schneider and Asllani (2022), and OECD (2023). Also, increased labor market flexibilities, such as in working hours, increased incentives for informal activities to become formal while keeping similar flexibilities. Significant progress in digitalization, including in improving infrastructure and improving digital public services, also supported progress in improving tax morale and integrating the self-employed (Medina and Schneider (2018) and Schneider and Asllani (2022). Meanwhile, the modernized employment information system also eased the burden of registration while increasing monitoring that incentivized compliance. Another related factor for higher tax morale could be related to policy continuity with political stability and reduced corruption, consistent with arguments on the institutional drivers of informality Devine (2021) and Ohnsorge and Yu (2022). Furthermore, some rationalization of Greece's tax policies in recent years, such as reducing business income tax rates and marginal personal income tax, likely helped reduce the incentive for tax evasion Schneider and Asllani (2022).

**Figure 10. Greece: Level and Changes in Digital Skills**

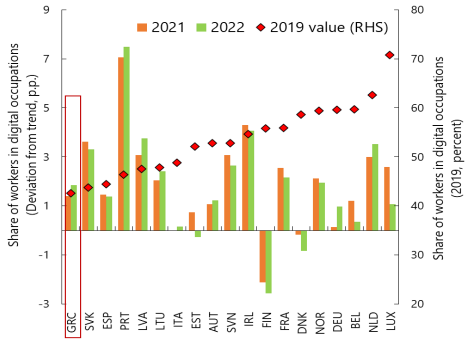
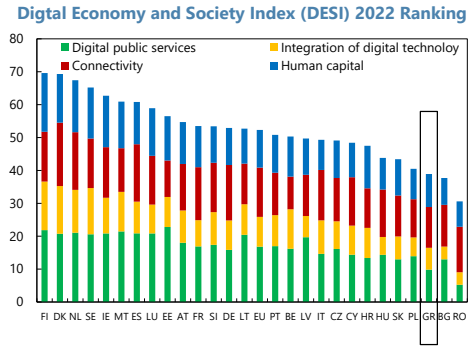



**Figure 11. Greece: Rating Index by Digitalization Aspects**




Sources: European Commission, Greece authorities, and IMF staff calculations.

**15. There is still strong potential for further strengthening digitalization to address remaining gaps and support reducing informality.** While Greece recorded above average increase in digital skills (Figure 10), the corresponding level is still on the low end among euro area peers, showing strong potential for further improvement EC (2023b). In addition, there are remaining gaps in some aspects of digitalization, such as the integration of digital technology and in digital public services particularly for Small and Mediums Enterprises, that require continued efforts to incentivize formal activities (Figure 11). For example, more integrated information systems can enhance monitoring of tax compliance, ease business and employment registration and access to related public services, and better integrate the self-employed into the formal economy. Furthermore, the strong emphasis on digitalization and related skill training in the authorities' National Resilience and

Recovery Plan supported by the Next General EU funding also offers a strong promise for additional progress in the coming years.

**16. Moreover, cross-country studies underscore the importance of other structural reforms to further reduce informality.** Improving regulatory quality and transparency would ease the burden for business entry and support more productive competition OECD (2023), Medina and Schneider (2018), Ohnsorge and Yu (2022), and Schneider and Asllani (2022). In addition, increasing the efficiency in spending on education and training would also increase industry-relevant skills, job matching, and the incentive for formal employment Kelmanson and others (2019). Other related measures include more targeted employment support, such as for youth and women who still face a disproportionately elevated unemployment rates in Greece. Furthermore, reforms to better link firm and job formalization with access to finance can enhance the incentive to formalize Ohnsorge and Yu (2022). Finally, the relatively high level of self-employment in Greece warrants more concerted efforts to ensure that the corresponding activities are appropriately integrated in the formal economy Schneider and Asllani (2022).

# Appendix I. Description of the Multiple Indicator Multiple Cause Model

The Multiple Indicator Multiple Cause (MIMIC) model is the prevailing modeling approach in the literature to estimate the size of the informal economy. It links multiple observable indicators of the informal economy to multiple observable causes of the informal economy through a latent variable. The latent variable is an index of the informal economy that can be used to calculate the size of the informal economy through variable transformation and calibration.

**The MIMIC Model**

The MIMIC model consists of a structural equation and a measurement equation. Let $y_t^*$ be the latent index of the informal economy, which is assumed to be determined by a $q \times 1$ vector of causes $x_t = (x_{1t}, \cdots, x_{qt})'$ through a linear structural equation:

$$y_t^* = \alpha' x_t + \eta_t,$$

where $\eta_t$ is a structural disturbance that captures the component of the informal economy not explained by the causes $x_t$. Let $y_t = (y_{1t}, \cdots, y_{pt})'$ be a $p \times 1$ vector of linear indicators of the latent index of the informal economy. The measurement model follows:

$$y_t = \beta y_t^* + \epsilon_t.$$

The disturbances are assumed to be mutually independent:

$$E(\eta_t \epsilon_t') = 0', E(\eta_t^2) = \sigma^2, E(\epsilon_t \epsilon_t') = \Theta^2.$$

The reduced-form equation of the MIMIC model is then:

$$y_t = \beta \alpha' x_t + (\beta \eta_t + \epsilon_t).$$

In essence, the MIMIC model is therefore a regression equation of $y_t$ on $x_t$ with two restrictions. First, the coefficient matrix before $x_t$, i.e., $\Pi = \beta\alpha'$, has rank one. Second, the covariance matrix of the error term is the sum of a rank-one matrix and a diagonal matrix $\Omega = E[(\beta\eta_t + \epsilon_t)(\beta\eta_t + \epsilon_t)'] = \sigma^2 \beta\beta' + \Theta^2$.

Note that if $\alpha$ and $\sigma$ are multiplied by a scalar and $\beta$ is divided by the same scalar, the reduced-form equation remains unchanged. As such a normalization is needed in order to pin down $\alpha$ and $y^*$. As with the practice in the literature, it is assumed that the first indicator has the same unit as $y^*$. In other words,

$$y_{1t} = y_t^* + \epsilon_{1t}.$$

The MIMIC model can be estimated by the maximum-likelihood estimation.

### Data Transformation

As the analysis uses data at the subnational level, indicators and causes might vary only slightly across regions within a country but significantly across countries. To account for institutional and cultural differences, country fixed effects should be added in the analysis. To this end, all variables are demeaned at the country level. For example, the $i$th indicator $y_{ijt}$ of country $j$ at time $t$ is transformed to $y_{ijt} - \overline{y_{ij}}$, where $\overline{y_{ij}}$ is the average of the $i$th indicator for country $j$ over all time periods. The same transformation is applied to the cause variables.

### From Index to Size of the Informal Economy

Once $\alpha$ is estimated as $\hat{\alpha}$, the index of the informal economy can be calculated as $\widehat{y_t^*} = \hat{\alpha}' x_t$. $\widehat{y_t^*}$ has the same unit as $y_{1t}$ due to the normalization discussed above. However, the unit of $y_{1t}$, either as percentage point or percent change, does not always imply that this should be interpreted as the size of the informal economy, rescaling of $\widehat{y_t^*}$ is therefore also needed. Moreover, because of recentering of indicator and cause variables, $\widehat{y_t^*}$ needs to be re-calibrated to match the correct size of the informal economy at one point in time or on average.

Let $z_t$ be the size of the informal economy. Assume $\widehat{y_t^*}$ has a unit of percentage point. Then the level index of the informal economy $s_t = \sum_1^t \widehat{y_t^*}$ . Suppose at two points in time the size of the informal economy is known, i.e., $z_{t1}, z_{t2}$ are known. The size of the informal economy can be calibrated as

$$z_t = \lambda s_t + \delta,$$

where

$$\lambda = \frac{z_{t2} - z_{t1}}{s_{t2} - s_{t1}} = \frac{z_{t2} - z_{t1}}{\sum_{t1}^{t2} \widehat{y_t^*}},$$

and

$$\delta = z_{t1} - \lambda s_{t1}.$$

With more data points on the size of the informal economy, $\lambda$ an $\delta$ can be estimated through an Ordinary Least Squares regression.

# Appendix II. Details on MIMIC Results

## Appendix II. Table 1. Greece: MIMIC Estimation Results

| Structural | | | | |
|---|---|---|---|---|
| Informal | coefficient | std.err. | z | p-value |
| agriculture employment share (%) | 0.47 | 0.12 | 4.02 | 0.00 |
| self employment share (%) | 0.16 | 0.11 | 1.51 | 0.13 |
| unemployment rate (%) | 0.27 | 0.08 | 3.42 | 0.00 |
| tourist arrivals as mutiple of population | -0.01 | 0.00 | -6.24 | 0.00 |
| (lagged) GDP per capita | 0.32 | 0.03 | 10.63 | 0.00 |
| population aged 25-64 with secondary education or lower (%) | -0.67 | 0.09 | -7.90 | 0.00 |
| VAT gap | 0.59 | 0.05 | 11.74 | 0.00 |
| tax (% of GDP) | -2.16 | 0.32 | -6.74 | 0.00 |
| trade openness | -0.46 | 0.05 | -9.35 | 0.00 |
| government consumption (% of GDP) | 1.14 | 0.25 | 4.52 | 0.00 |
| rule of law | -0.08 | 0.02 | -3.76 | 0.00 |
| control of corruption | 0.02 | 0.02 | 1.31 | 0.19 |
| government effectivenss | -0.03 | 0.02 | -1.35 | 0.18 |
| political stability | 0.16 | 0.02 | 7.74 | 0.00 |
| Measurement | | | | |
| (-) GDP growth | | | | |
| Informal | 1 (constrained) | | | |
| labor participation rate growth | | | | |
| Informal | -0.14 | 0.01 | -9.79 | 0.00 |
| Google Search Volume growth | | | | |
| Informal | -0.13 | 0.53 | -0.24 | 0.81 |
| Nighttime light growth | | | | |
| Informal | -0.07 | 0.10 | -0.73 | 0.47 |

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