EFFECTS OF A SOVEREIGN CREDIT RATING UPGRADE TO INVESTMENT GRADE ON THE GREEK ECONOMY

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ABSTRACT

The paper investigates the potential effects of a sovereign credit rating upgrade to investment grade on the trajectory of the Greek economy. A cross-country empirical analysis of past upgrades suggests that an economy's upgrade to investment grade is associated with a reduction in sovereign bond yields and spreads by about 70 basis points. In the long run, such an upgrade boosts real GDP and reduces GDP volatility by 2.5% and 0.48%, respectively. Furthermore, the findings derived from a dynamic factor model indicate that an upgrade to investment grade is expected to reduce Greek sovereign bond yields and pass through to the Greek banking sector by reducing its funding costs and narrowing the spread between Greek and euro area bank bonds. Subsequently, a DSGE model featuring a rich financial sector, calibrated to the Greek economy, is employed to trace the dynamic responses of key financial and real variables to an upgrade to investment grade. The model suggests that an upgrade to investment grade that reduces bank funding costs has a positive impact on the real and financial sectors of the Greek economy in both the short and the long run. Finally, counterfactual experiments illustrate that a sovereign credit rating upgrade to investment grade has a stabilising effect on both the banking sector and the real economy in the face of adverse shocks.

Keywords: credit ratings; investment grade threshold; cost of funding; GDP growth; economic resilience

JEL classification: E37; E43; E44; G11; G12; G21

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ΟΙ ΕΠΙΔΡΑΣΕΙΣ ΤΗΣ ΠΙΣΤΟΛΗΠΤΙΚΗΣ ΑΝΑΒΑΘΜΙΣΗΣ ΤΗΣ ΕΛΛΑΔΟΣ ΣΤΗΝ ΕΠΕΝΔΥΤΙΚΗ ΚΑΤΗΓΟΡΙΑ

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ΠΕΡΙΛΗΨΗ

Η μελέτη εξετάζει τις δυνητικές επιδράσεις μιας αναβάθμισης της κρατικής πιστοληπτικής αξιολόγησης της Ελλάδος στην επενδυτική κατηγορία για την ελληνική οικονομία. Αρχικά, παρουσιάζεται εμπειρική διερεύνηση, χρησιμοποιώντας ένα μεγάλο δείγμα οικονομιών, τόσο αναπτυσσόμενων όσο και ανεπτυγμένων, ορισμένες εκ των οποίων αναβαθμίστηκαν στο διάστημα 2000-2022. Εκτιμάται ότι η αναβάθμιση στην επενδυτική κατηγορία επιφέρει μια μόνιμη μείωση των αποδόσεων των κρατικών ομολόγων κατά περίπου 70 μονάδες βάσης, την περίοδο 3 μήνες πριν έως και 3 μήνες μετά την αναβάθμιση, καθώς και σημαντικές μακροοικονομικές επιδράσεις, όπως αύξηση του πραγματικού ΑΕΠ, σε βάθος χρόνου, κατά 2,5% και μείωση της μεταβλητότητάς του κατά 0,48%. Στη συνέχεια, η μελέτη εξετάζει τις δυνητικές επιδράσεις μιας αναβάθμισης στην επενδυτική κατηγορία για την ελληνική οικονομία. Αρχικά, εκτιμάται η μείωση του κόστους χρηματοδότησης για το Ελληνικό Δημόσιο που αναμένεται ως συνέπεια της αναβάθμισης, με τη χρήση υποδειγμάτων καμπύλης αποδόσεων. Κατόπιν, διερευνώνται οι δυνητικές επιδράσεις της εν λόγω μείωσης στον πραγματικό και στο χρηματοπιστωτικό τομέα της ελληνικής οικονομίας στο πλαίσιο ενός δυναμικού στοχαστικού υποδείγματος γενικής ισορροπίας. Στόχος είναι η ανίχνευση και κατανόηση των μηχανισμών μετάδοσης της θετικής αυτής διαταραχής στην πραγματική οικονομία και τον τραπεζικό τομέα, καθώς και η ποσοτική προσέγγιση των αναμενόμενων επιδράσεων μέσω προσομοιώσεων του υποδείγματος. Σύμφωνα με τα ευρήματα της προσομοίωσης στο πλαίσιο του υποδείγματος, μια αναβάθμιση του Ελληνικού Δημοσίου στην επενδυτική κατηγορία οδηγεί σε μόνιμη αύξηση του επιπέδου των βασικών οικονομικών και χρηματοπιστωτικών μεγεθών. Μακροπρόθεσμα, το επίπεδο του πραγματικού ΑΕΠ αυξάνεται και ενισχύονται τα τραπεζικά κεφάλαια και οι πιστώσεις. Επιπρόσθετα, επιδρά σταθεροποιητικά τόσο στον τραπεζικό τομέα όσο και στην πραγματική οικονομία.

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1 INTRODUCTION

With the exception of the pandemic downturn, the Greek economy has been growing at a fast pace in recent years, recording increases in investment and exports, as well as a sharp decline in the ratio of public debt to GDP. This marked progress has been reflected in declining sovereign spreads and a steadily improving sovereign credit rating. The eager anticipation of Greece's sovereign credit rating upgrade to investment grade raises the question of whether such an upgrade may itself have an effect on the trajectory of the Greek economy.

While the impact of sovereign credit ratings on the pricing of securities is well established in the literature, their macroeconomic impact has received less attention. Even scarcer is academic research that specifically explores the possible implications of a sovereign credit rating upgrade from non-investment grade to investment grade status. This study attempts to explore the implications of an upgrade of the Greek economy to investment grade, motivated by the change of the economy's sovereign credit rating outlook to positive by S&P in April 2023 and seen from that point in time.[1]

The remainder of the paper is structured as follows: Section 2 offers a brief review of the literature. Section 3 presents cross-country evidence regarding the impact of an economy's upgrade to investment grade on sovereign bond yields and spreads, as well as on equities, using generalised method of moments (GMM) estimations. Section 4 focuses on the potential impact of such an upgrade on the Greek economy. First, we employ a dynamic factor model to estimate the credit risk component of 10-year Greek government bonds and, ultimately, to gauge the effect of an upgrade on the funding costs of the sovereign and the banks. Subsequently, we use a dynamic stochastic general equilibrium model with a rich financial sector to provide a quantitative and qualitative assessment of the effects of the sovereign credit rat-

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

1 This study was completed in July 2023. The cut-off date for the data employed in the econometric analysis is 15.6.2023.

ing upgrade to investment grade on key financial and real variables. Finally, we perform counterfactual experiments to examine the possible impact of the upgrade on the resilience of the Greek economy. Section 5 presents our conclusions.

2 A BRIEF LITERATURE REVIEW

2.1 REAL EFFECTS OF A SOVEREIGN CREDIT RATING UPGRADE

The growth rate of GDP responds to changes in sovereign credit ratings via the interest rate or cost of funding channel and the capital flows channel. Regarding the former, sovereign credit rating upgrades directly affect the cost of funding of the government and are also associated with a decline in corporate bond yields and bank lending rates, which lowers the cost of capital for the whole economy. This lower cost transforms some of the investment projects which had a negative net present value (NPV) before the upgrade into projects with a positive NPV, thus leading to an increase in private investment and, therefore, output. Furthermore, lower interest rates, coupled with a decline in perceived country risk, also prompt an increase in the supply of credit, which further boosts output growth. Improved investor confidence, as a result of a rating upgrade, also works in the same direction.

Empirical evidence on the real effects of sovereign credit rating upgrades is limited. In a study of 103 countries over the period 1982-2012, a one-notch rating upgrade is estimated to lead to an increase of 0.6 percentage points (pps) in the subsequent five-year average annual growth rates of the re-rated countries, while the corresponding impact is 1.7 pps when the rating is close to the investment-grade threshold (Chen et al. 2016). Similarly, private investment growth increases by 4.5 pps in the year of the upgrade and by 3.2 pps in the following year, while the coefficient is insignificant for the subsequent years and for the cases where upgrades cross the investment grade – though the latter finding is probably due to the very small fraction of such cases (Chen et al. 2013).

Turning to the second channel, sovereign rating changes also impact capital flows, including FDI flows, as they mitigate the information asymmetry between foreign and domestic agents, thus improving the upgraded economy's access to international capital markets. In a panel study of emerging market economies, a one-notch rating upgrade results in an increase in FDI (as a percentage of GDP) of about 0.33%, or of 2.38% when moving from a speculative to an investment grade (Emara and El Said 2021). Cai et al. (2018) examine this relation in a panel of OECD countries and report similar findings, with the exception of a small subset of countries, including Greece, though the inclusion of the Greek sovereign debt crisis in the sample may be a confounding factor. Finally, significant causality effects run from sovereign ratings to measures of economic risk (Athari et al. 2021).

2.2 FINANCIAL EFFECTS OF A SOVEREIGN CREDIT RATING UPGRADE

Sovereign credit ratings remain a significant determinant of the corporate credit ratings of domestic firms (see e.g. Ferri et al. 2001; Borensztein et al. 2013; Cheikh et al. 2021; Wang and Xie 2022), despite the fact that credit rating agencies have gradually allowed for exceptions to their standing policy of never rating a corporation above the sovereign (the "country ceiling"). However, it has been found that the degree of spillover from sovereign to corporate rating is larger for downgrades than for upgrades (Borensztein et al. 2013). Specifically, it is reported that a two-notch upgrade of the sovereign rating would lead to an increase in the corporate rating by one notch.

Consistent with this rationale, it has been found, as aforementioned, that sovereign credit ratings or other measures of sovereign risk affect corporate spreads and the likelihood of

corporate bond issuance (see e.g. Eichengreen and Mody 2000; Bedendo and Colla 2015; Bevilaqua et al. 2020). Also, several studies document the close association between credit risk premia in sovereign bonds and sovereign credit ratings (see e.g. Malliaropulos and Migiakis 2018; El-Shaggi and von Schweinitz 2018). As such, a possible channel of transmission of sovereign credit rating changes to the economy works through the cost of corporate funding. In particular, on balance, the long-run pass-through of sovereign yields to corporate yields is around one-to-one, while it is larger for financial firms compared to non-financial firms (Li et al. 2023). Finally, there is evidence of reinforcing dynamics between yields, sovereign and bank ratings (Gibson et al. 2017), whereby a 1-notch change in the sovereign rating may, in the long run, lead to a 2.5-notch change in that same variable, a change in spreads of around 3 pps and a 2-notch change in bank ratings.

The investment-grade (IG) threshold is important for financial entities, due to its role in financial regulation[2] and its use by large institutional investors in their portfolio allocation mandates (see e.g. Ellul et al. 2011; Falato et al. 2021; Baghai et al. 2023). Thus, several papers have argued that there exists a "cliff effect" across the IG threshold for the pricing of debt in bond and credit markets, which increases the risk premia paid by downgraded entities beyond what would be explained by the size of the downgrade (see e.g. Jaramillo and Tejada 2011) and amplifies the effects of shocks on non-IG assets (see, among others, Cantor and Packer 1996; Acharya and Steffen 2020; Bevilaqua et al. 2020). Moreover, Jaramillo and Tejada (2011) show that a rating change to below (or above) the IG threshold adds (or deducts, respectively) 35 basis points (bps) to the bond yields of affected sovereigns, on top of what is explained by standard rating changes. In this respect, given the importance of the IG threshold for regulatory purposes, recent studies highlight the financial stability risks stemming from a potential wave of downgrades of IG assets to non-IG status (see Altman and Heine 2020; Chodorow-Reich et al. 2021).

Finally, an extensive body of literature has examined stock price reactions to credit rating announcements (see e.g. Griffin and Sanvicente 1982; Holthausen and Leftwich 1986; Hand et al. 1992; Goh and Ederington 1999; Jorion et al. 2005; Even-Tov and Ozel 2021). Using mostly monthly or multi-day announcement windows, this body of research shows that, on balance, credit rating downgrades often reveal new information and lead to significant stock price reactions, but upgrades do not. This could be an indication that usually markets have already incorporated information about upgrades by the time of their announcement.

3 CROSS-COUNTRY EMPIRICAL ANALYSIS

3.1 PREVIOUS CASES OF SOVEREIGN CREDIT RATING UPGRADES TO INVESTMENT GRADE

In the recent past, there have been several rating upgrades to investment grade. Using a large database for 77 economies worldwide, spanning the period from 1.1.2000 to 15.6.2023, we have identified 16 cases of upgrades to investment grade in the (foreign currency) credit ratings assigned by S&P, Moody's and Fitch to sovereigns previously belonging to non-investment grade. These are shown in Table 1, ordered from the most recent to the oldest one.

Table 1 shows that, in most cases, an upgrade to the IG category is preceded by a change in the outlook of the credit rating to positive. The average time lag between an outlook change to positive and an upgrade is about 8 months.[3]

2 For the application of the investment-grade threshold in the monetary policy framework, see Bindseil et al. (2017); for the capital adequacy framework, see Altman et al. (2002).

3 With the exception of Panama's upgrade. This case is treated as an exception because, after Fitch changed its outlook to positive, in early 2008, the turbulence in financial markets escalated and may have resulted in a reluctance of the rating agencies to proceed to an upgrade, amid the unfolding global financial crisis. Also, the three rating agencies examined herein had all downgraded Portugal to non-investment grade during the euro area debt crisis period; however, as DBRS had sustained a sovereign credit rating within the IG category for Portugal, we do not include this country among the ones listed in Table 1.

Table 1 Precedents of upgrades of sovereign credit ratings to investment grade

Country	Date of upgrade to IG	Date of positive outlook	Rating agency
Croatia	22/3/2019	21/9/2018	S&P
Cyprus	14/9/2018	15/9/2017	S&P
Hungary	20/5/2016	22/5/2015	Fitch
Philippines	27/3/2013	-	Fitch
Turkey	5/11/2012	-	Fitch
Uruguay	3/4/2012	-	S&P
Indonesia	15/12/2011	-	Fitch
Panama	23/3/2010	29/1/2008	Fitch
Brazil	30/4/2008	16/5/2007	S&P
Romania	6/10/2006	7/6/2006	Moody's
India	22/6/2004	16/10/2003	Fitch
Bulgaria	4/6/2004	24/7/2003	S&P
Russia	18/10/2003	28/7/2003	Moody's
Slovakia	30/10/2001	9/11/2000	S&P
Mexico	3/7/2000	2/2/2000	Moody's

Source: Refinitiv.
Note: The date of the upgrade to investment grade (IG) is the date on which the first of the three major rating agencies (namely, Fitch, Moody's and S&P) upgraded the economy in question to investment grade.

Exceptions to the rule that an IG upgrade is preceded by a change in the outlook of the sovereign to positive are mostly related to emerging markets in the aftermath of the global financial crisis; emerging market economies (EMEs) were noted during the turbulence as an exception to the developments in the world economy. In fact, they were considered to be net winners of the global financial crisis. As a result, despite the downgrade cycle of that period, in the case of EMEs rating agencies proceeded to upgrades, although with a slight delay in comparison to the improvements in emerging market countries' fundamentals. Finally, the last column of Table 1 shows the credit rating agency that first assigned an IG rating to the sovereign of interest.

Using the information provided in Table 1, we can then gauge the evolution of various financial indicators around the event of the IG upgrade. In particular, we have re-based sovereign bond yields and spreads and equity market returns, so that they take the value of 100 at the base date, i.e. 3 months before the upgrade of the sovereign rating to the IG category. In this way, we construct indices which are then rolled on, up until 3 months after the upgrade, and reflect the percentage point change in each indicator at t+3m vis-à-vis its value at the base date (i.e. t-3m).

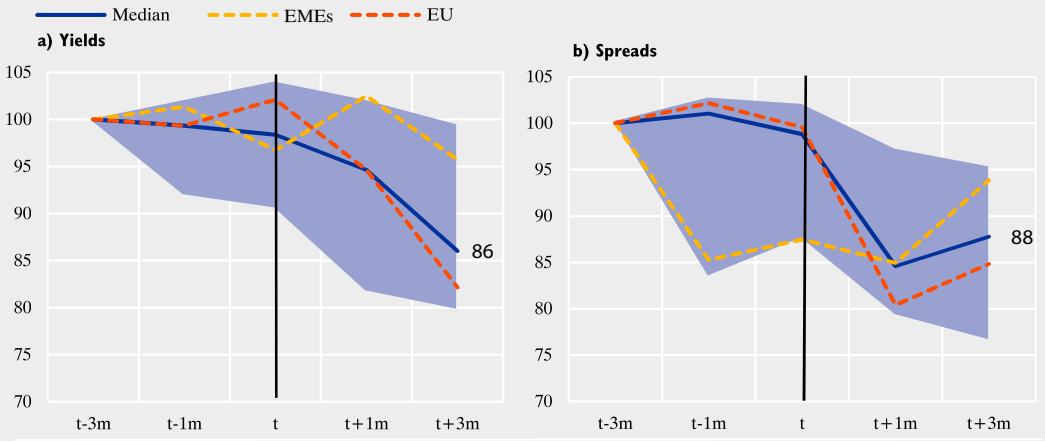
Chart 1 below illustrates the developments in sovereign bond yields for a period of 3 months before (i.e. from t minus 3 months) and 3 months after (i.e. up to t plus 3 months) the upgrade.[4] Panel (a) illustrates the level of yields, at each point in time, relative to their value at the beginning of the examination period. Panel (b) illustrates the same developments, when gauged through the yield differentials between the countries that were upgraded and a benchmark country (i.e. Germany for euro area and EU sovereigns and the US for all other countries).

Chart 1 shows that, 3 months after the upgrade, yields and spreads experience a similar movement: yields decline by 14% compared to their initial level (3 months before the

4 Sovereign bond yield data were available for Brazil, Bulgaria, Croatia, Cyprus, Hungary, the Philippines, Indonesia, India and Turkey.

Chart 1 Evolution of sovereign bond yields and spreads around the time of the investment grade upgrade

(yield/spread at t-3m=100)



Sources: LSEG, Refinitiv (data); Bank of Greece (calculations).
Notes: The lines show the evolution of sovereign bond yields (panel a) and spreads (panel b) vis-à-vis benchmark bonds, re-based at their level three months (t-3m=100) before the upgrade of the sovereign credit rating to the investment grade. The solid blue line is the median of the re-based series and the light blue shaded area is their interquartile range (75th-25th percentile). The dashed red line is the median of the series for bonds from European Union (EU) countries and the dashed orange line is the corresponding median for emerging market economies (EMEs). The vertical black line indicates the timing (t) of the sovereign credit rating upgrade to the investment grade.

upgrade), while spreads decline by 12%. This means that, for a sovereign with a yield of 7% and a spread over the benchmark of 500 bps, the upgrade is expected to be associated with a reduction of 100 bps in its yield and of about 60 bps in its spread. This reduction is measured as the overall evolution during the 6-month window applied; however, according to the precedents we have examined, the larger part of the fall in spreads is expected to come about in the 3 months following the upgrade.

Nevertheless, this observation involves some degree of heterogeneity: the coloured lines in the two panels of Chart 1 show the movements of yields and spreads in different groups of countries that have experienced an IG upgrade. The dashed red line in both panels corresponds to the median of European countries and the orange line to the median of emerging market economies (EMEs). The picture in both panels is uniform: European spreads and yields decline relatively more than those of EMEs.

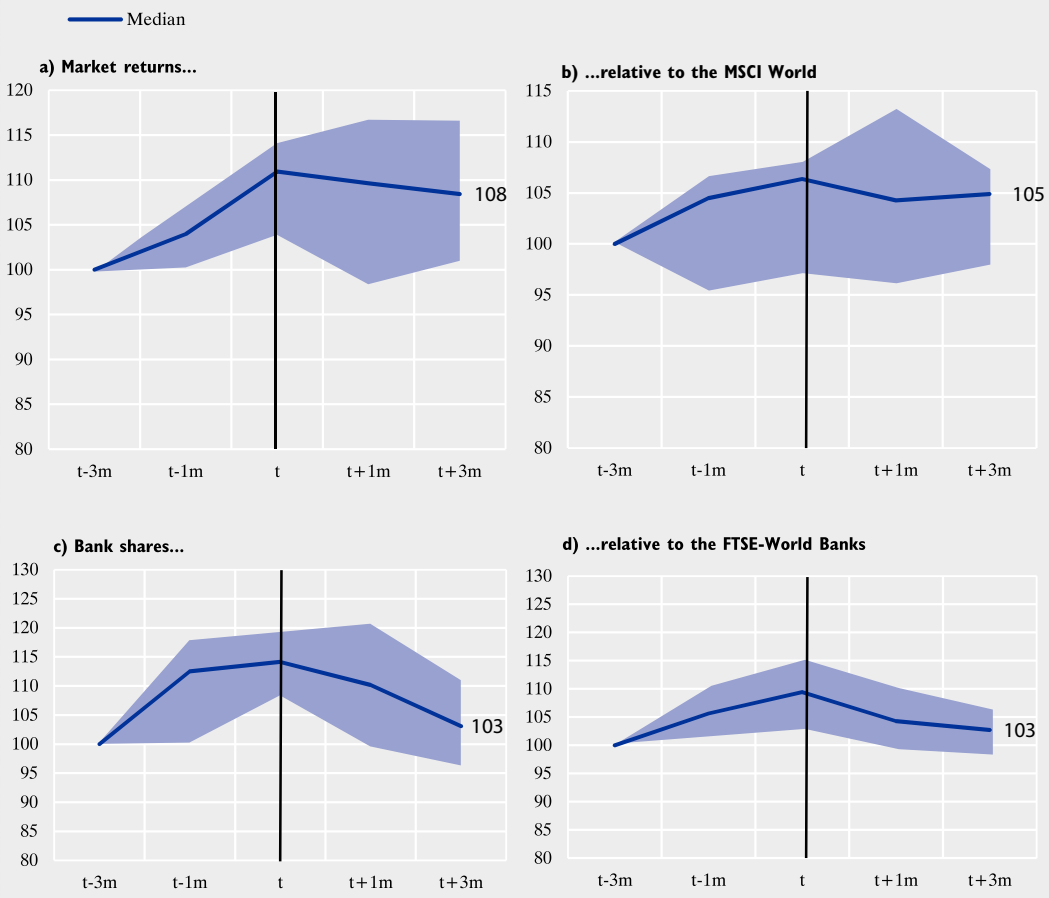
For equity markets, we construct two types of indicators.[5] The first one measures the level of the stock market price index at each point in time, against its level at the base date. We use both the general price index of each country's stock market and the country's banking index. The second group of measures intends to extract information about the returns of these indices in excess of those of indices capturing world developments. In particular, at the base date (t-3 months), the country-specific general index is taken as a ratio to the MSCI World index, and the corresponding banking index is taken as a ratio to the FTSE World Banks index, which captures share price developments in the banking sector worldwide. Then, these ratios are rolled over for the subsequent periods. Chart 2 below illustrates the findings.

Chart 2 shows that share prices, as measured by the general stock market indices of the countries in our sample, rise significantly in the period preceding the IG upgrade: the general stock market indices rise by about 11 pps

5 Data availability restricts the analysis for equity markets to the following economies: Brazil, Bulgaria, Croatia, Cyprus, Hungary, India (excluding banks), Indonesia, Mexico, the Philippines, Romania, Slovakia and Turkey.

Chart 2 Stock market developments around the time of IG upgrades

(stock index at t-3m=100)



Sources: LSEG, Refinitiv (data); Bank of Greece (calculations).
Notes: The panels show the evolution of share price indices, re-based at their level three months (t-3m=100) before an upgrade of the sovereign credit rating to the investment grade. The blue line is the median of the re-based series and the light blue shaded area is their interquartile range (75th-25th percentile). Panels a) and b) show developments in the equity markets of selected countries around the time of the IG upgrade, while panels c) and d) correspond to developments in bank share prices. Panels a) and c) show the level of the general and banking sector stock market indices at each time t, relative to their level three months before the IG upgrade (i.e. index=$P_\tau/P_{\tau-3m}$, where $\tau=\{t-3m, t-1m, t=0, t+1m, t+3m;$ t=day of IG upgrade$\}$). Panels b) and d) show the same developments for the general and banking sector indices relative to MSCI World and FTSE-World Banks, respectively.

before the upgrade and smooth down by about 3 pps three months after that. Overall, in the period spanning from 3 months before to 3 months after the IG upgrade, the general stock market indices rise by about 8%. Relative to world stock market developments, this rise is somewhat lower: in the three months preceding the upgrade, the stock market rises by 6 pps above the MSCI World, while this development is smoothed down by 1 pp in the three months after achieving the IG status. Nevertheless, the median excess return of the stock markets in economies upgraded to the IG category vis-à-vis the world market is 5% in the 6-month period around the event.

The share prices of the banking sector in upgraded countries outperform their peers

elsewhere. In particular, the statistics indicate that the share prices of banks in countries upgraded to IG rise by 3% vis-à-vis the global banking sector in the period from 3 months before to 3 months after the upgrade. This is an important finding, as it may indicate that Greek banks will face more favourable conditions in raising equity capital after the upgrade of the Greek sovereign rating to investment grade.

3.2 DYNAMIC PANEL GMM ESTIMATES

Effects on sovereign bond yields

The next step in our analysis is to formally estimate the effects of an upgrade to investment grade on the yields and spreads of sovereign bonds. In this sub-section we make use of a large dataset of 77 countries' bond yields and ratings, augmented by the inclusion of the annual percentage changes in their foreign exchange rates against the US dollar and of a proxy for global monetary policy.[6] Data are in daily frequency and cover the period from 1.1.2000 to 15.6.2023. The estimated equation is the following:

$$r_{it}=\alpha_i+\beta_1 c_{it}+\beta_2 EFFR_t+\beta_3 \%\Delta FX_{it} +\beta_4 I_{it}^{t-3m,t+3m}+e_{it} \quad (1)$$

where:

r_{it} is the yield on the ten-year bond of country i=1, 2,...N, at each point in time t=1, 2,...T;

c_{it} is the rating of country i (at each point in time t);

$EFFR_t$ is the effective Fed funds rate at each point in time t;

$\%\Delta FX_{it}$ is the annual rate of return of the exchange rate of the currency of country i against the US dollar (1 USD/FX), with positive values denoting depreciations and negative values appreciations of the currency;

$I_{it}^{t-3m,t+3m}$ is an index taking the value of 1 in the period 3 months before and 3 months after an upgrade across the IG threshold for the country that has been upgraded and 0 in all other cases (i.e. countries and periods).[7]

The variable of interest here is obviously the index $I_{it}^{t-3m,t+3m}$. Since, however, the literature has established the existence of monetary policy effects globally, we also insert the effective Fed funds rate (EFFR) to control for global monetary policy effects. Ratings and the dynamics of foreign exchange rates are introduced in order to capture country-specific effects that are not adequately captured by the fixed effects also included in the model. Finally, due to the need to address data properties whose roots in many cases exceed the unity threshold of non-stationarity, the estimation of the above equation has been done using Dynamic Least Squares, i.e. a cointegration technique for heterogeneous panels.

Table 2 reports the results. From the estimation of equation (1), we conclude that the upgrade to investment grade deducts about 52 basis points from the 10-year bond yield of the sovereign which achieved this upgrade during the 6-month period around the event of the upgrade (coefficient β_4). Note that this finding comes on top of the effects captured by the other variables in the setup, which include positive effects stemming from the proxy of global monetary policy conditions, as well as country-specific developments captured by ratings and the depreciation of the currency (reflected in positive values of the variable $\%\Delta FX_{it}$). Among them are the reduction effects exercised by the smaller value of the rating variable due to the upgrade; this deducts another 19 basis points (coefficient β_1). All in all, the IG upgrade is expected to deduct about 70 basis points from the 10-year bond yields of the upgraded sovereign during the quarter before and after the event.

6 The setup is based on the one employed in Malliaropulos and Migiakis (2023).

7 For this variable we have examined alternative definitions as well, such as a variable that spans a period 6 months before up to 6 months after the upgrade or one that marks the upgrade only after the rating is upgraded by two rating agencies to the IG. Our results do not change significantly.

Table 2 Estimates of the effects of an IG upgrade on sovereign bond yields

β_1: Ratings	β_2: Effective FFR	β_3: Foreign exchange	β_4: IG threshold
0.197*** (0.014)	0.327*** (0.009)	0.021*** (0.001)	-0.520*** (0.207)
Adjusted R-squared	J-B	ADF z-stat	LLC t-stat
66.9%	16579k [0.000]	-14.652 [0.000]	-12.598 [0.000]

Notes: The above cointegration setup is estimated using Dynamic Least Squares with leads and lags selected according to the AIC. Long-run variances and cross-section fixed effects are included in the estimation. Asterisks (***, ** and *) denote significance (at 1%, 5% and 10%, respectively). Figures in parentheses are standard errors and those in brackets are p-values.

Effects on economic activity

Next, we examine the effects that a rating upgrade has on the growth rate of real GDP. To do so, we again draw on previous experience, based on data for about 85 economies worldwide. Data are at an annual frequency for the period from 2000 to 2020.[8] The dynamic panel GMM setup estimated is of the following form:

$$\Delta Y_{it} = \varrho \Delta Y_{it-1} + \beta \Delta X_{it} + \gamma IG_{it} + F_t + e_{it} \qquad (2)$$

where:

Y is one of the following variables: real GDP growth, GDP volatility and fiscal balance;

X is the vector of regressors, including the IG-upgrade dummy;

F is an index controlling for specific years/periods effects (i.e. period fixed effects).

The variable of interest IG_{it}, namely the IG upgrade, is constructed so that it captures the new state of the economy as belonging to investment grade. In particular, for economies upgraded to IG from non-IG by at least one of the three major rating agencies, the variable takes the value of 1 for the year of the upgrade and the years thereafter and 0 in all other cases (i.e. years and countries). For the estimation of the above setup, we use Arellano-Bond estimators to remove moving average (MA) components. Alternative setups (including system GMM and dynamic panel FE models) have been examined, but their properties have been found to be inferior to the AB-DPD model used herein. Table 3 reports the results of the estimations.

Table 3 Estimates of the effects of an IG upgrade on real GDP

	ϱ	β
Real GDP growth	0.684*** (0.002)	0.801*** (0.137)
GDP volatility	0.161*** (0.007)	-0.403*** (0.001)

Notes: The above dynamic panel data setups are based on Arellano-Bond estimators, with errors robust for serial correlation and cross-section heterogeneity (White period coefficient covariance and cross-section clusters). Long-run variances and cross-section fixed effects are included in the setup. Instruments used in the estimations, apart from the dependent variable's lagged values, are: (for the real GDP growth equation) changes in the current account balance, changes in the fiscal balance, changes in broad money supply, an index variable capturing the status of the currency as a global reserve, the average ranking of the country in governance indicators, history of default, GDP volatility and period fixed effects. In the equation of GDP volatility, we also add interest expenses, while for the fiscal balance, on top of the previous instruments, we also add debt-to-GDP ratios. Asterisks (***, ** and *) denote significance (at 1%, 5% and 10%, respectively).

Our estimates reported in Table 3 suggest that, following the IG upgrade, countries that have been upgraded are expected to have:

(a) 0.8 pps higher real GDP growth rates;

and

(b) 0.4 pps lower GDP volatility;

8 The data source is Fitch Ratings. The full dataset covers 117 sovereigns, although data adequate for our purposes are available for 85 countries.

Given that the setup includes an autoregressive term (coefficient: ϱ), we may infer the anticipated long-run effects from the above estimates by the formula: $\frac{\beta}{1-\varrho}$. In this regard, the long-run effects of the IG upgrade are expected to be a 2.5% higher GDP level and a 0.48% lower GDP volatility level. Thus, according to these results, the IG upgrade is expected to have economically significant effects, pushing up economic activity and enhancing the resilience of the upgraded economy. On the other hand, our sample includes a large number of emerging market economies, for which the effects of upgrades to IG may be particularly strong. Hence, these estimates should be interpreted as an upper bound.

4 IMPACT OF A SOVEREIGN CREDIT RATING UPGRADE TO INVESTMENT GRADE ON THE GREEK ECONOMY

4.1 IMPACT ON THE COST OF FUNDING

In general, cross-country differences in the cost of sovereign funding reflect differences in the monetary policy outlook, uncertainty about future short-term interest rates and credit risk. Since there is a common monetary policy in the euro area, differences in sovereign bond yields between member countries should largely reflect differences in the credit risk of sovereigns. We have estimated the credit risk component of 10-year Greek government bonds using a dynamic factor model for defaultable sovereign bonds along with the respective credit risk components of Italian and Portuguese government bonds.[9]

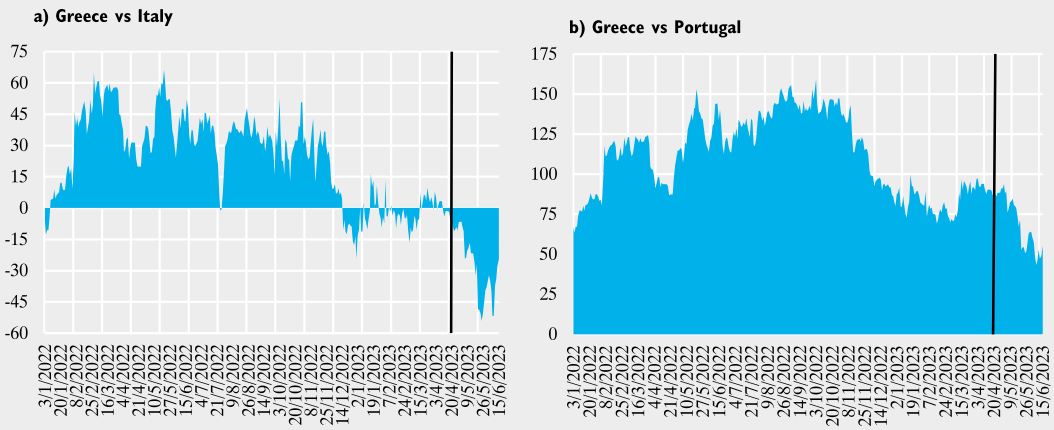
As shown in Chart 3, from the date of the announcement of the positive outlook by S&P[10] to the end of our sample period, the risk

9 The model is a time-varying affine term structure model (a Dynamic Nelson-Siegel model; for the methodology, see Diebold and Li 2006). The technique used for decomposing interest rates is based on Bauer and Rudebusch (2020). We chose Italy and Portugal for comparison because both countries are IG, but they are the ones closest to the rating of Greece.

10 On 21 April 2023, S&P changed the outlook of Greece's sovereign rating to positive from stable; with a rating standing at BB+ at the time, i.e. just one notch below investment grade, this development signalled that an upgrade of Greece's sovereign rating was very likely in the next 12-18 months, according to the rating agency's definition.

Chart 3 Sovereign bond yields: differences in credit risk components

(basis points)



Source: Bank of Greece (econometric model).
Notes: The credit risk components for each country have been estimated from an affine term structure model (of the dynamic Nelson Siegel type), that allows the decomposition of their sovereign bond yields into an expectations component, a term premium and a credit risk premium. The blue areas show the ratio of the credit risk component of the Greek 10-year sovereign bond to the credit risk components of Italy (panel a) and Portugal (panel b). The black lines mark 21 April 2023, when the rating agency S&P revised its outlook on Greece to positive, signalling a probable upgrade to investment grade.

premia demanded by investors for holding Greek sovereign bonds decreased by about 30 bps relative to the credit risk components of other euro area sovereign bonds, such as the Italian and the Portuguese ones. This development explains the largest part of the 40 bps reduction in Greek sovereign bond yields in the same period.[11] Thus, the credit risk differential of Greek sovereign bonds vis-à-vis Italian ones has remained steadily negative (standing at -25 bps on 15.6.2023) since S&P's announcement of a positive outlook for the sovereign rating on Greece, despite the fact that throughout this period Italy was rated in the IG category, whereas at the time Greece was not.[12] So, the negative default risk differential may indicate that investors discount the high likelihood of an upgrade of Greece to IG in the near future.

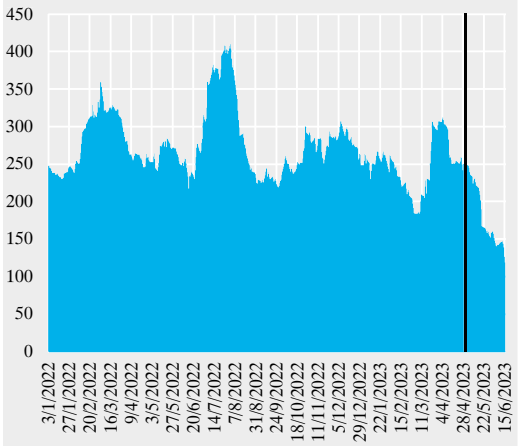
At the same time, the comparison of the credit risk premia on Greek sovereign bonds to those on Portuguese bonds[13] indicates that, despite the discounting of a likely upgrade, there may still be room for further compression of funding costs for the Greek State. In particular, the credit risk differential between the two countries' sovereign bonds stands at +55 bps at the end of our sample period (on 15.6.2023). Based on the findings reported in Section 2, which indicate that the IG upgrade is associated with an overall reduction in yields of about 70 bps, in the case of an actual upgrade of Greece, a further compression of the credit risk component may be anticipated, which could lead to an additional yield reduction of up to 40 bps. Such a hypothetical development would still leave a positive spread of at least 15 bps, *ceteris paribus*, in the credit risk component of Greek government bonds vis-à-vis those of Portuguese bonds.

The effect of an upgrade of the Greek sovereign to the IG category is expected to pass through to the cost of funding of Greek banks both directly and indirectly. The indirect channel is related to the fact that, in all previous cases, an upgrade of the Greek sovereign credit rating has been followed by an upgrade of Greek banks' ratings. So, an upgrade of Greece's sovereign rating to IG is expected to enable future upgrades of Greek banks to IG.[14] The direct channel is related to how bonds are priced in the market: since sovereign bonds are benchmarks for pricing all other bonds with exposure to the same economy, a significant change (i.e. either a rise or a decline) in the yields of sovereign bonds passes through to corporate and bank bonds.

Chart 4 illustrates the yield differential between senior bonds issued by Greek banks and those issued by euro area banks with similar characteristics, except for their rating. As shown in Chart 4, the reduction of risk premia

Chart 4 Yield differentials of senior bank bonds: Greek vs EA banks

(basis points)



Sources: LSEG, Refinitiv.
Note: The blue area illustrates the differential (spread) of the weighted average yield on Greek bank bonds vis-à-vis the yield on the iBoxx index for senior BBB-rated bank bonds denominated in euro and with a residual maturity of five to seven years. The black line marks 21 April 2023, when the rating agency S&P revised its outlook on Greece to positive, signalling a probable upgrade to the investment grade.

11 Another 10 bps reduction in yields is associated with lower term premia.
12 Italy is rated by Fitch and S&P at BBB and by Moody's at Baa3.
13 Portugal is rated by Fitch and S&P at BBB+ and by Moody's at Baa2.
14 On 15.6.2023, the highest issuer-default ratings of Eurobank and National Bank of Greece assigned by Fitch, Moody's and S&P stood at BB-, i.e. 3 notches below the IG threshold; Alpha Bank's issuer-default rating stood at B+ (4 notches below IG) and Piraeus Bank's at B (5 notches below IG).

in Greek sovereign bonds after S&P changed Greece's sovereign rating outlook to positive has been reflected in and amplified by the movements of Greek bank bond yields: their spread over euro area bank bonds belonging to investment grade has come down by about 140 basis points. At the end of our sample period, this spread stood at around 115 basis points.

Extending the sample period until the beginning of September, we observe that in anticipation of an upgrade to the IG category the risk premia on Greek sovereign bonds declined by more than 50 basis points vis-à-vis the credit risk components of comparable euro area sovereign bonds with an IG rating. Thus, as indicated above, the overall decline in the credit risk premia of Greek sovereign bonds in anticipation of an IG upgrade stood close to the 70 bps reduction in sovereign bond yields observed in previous cases of IG upgrades, as documented in Section 2. Turning to the likely impact of an IG upgrade on bank bonds, since S&P announced the positive outlook for the Greek sovereign rating, yields on senior bonds issued by Greek banks have been reduced by more than 150 basis points relative to those of euro area peers with an IG rating. Furthermore, an upgrade of Greece's sovereign credit rating to the IG category is expected to be followed by rating upgrades of Greek banks. In turn, rating upgrades of Greek banks would, in all likelihood, lead to a further compression of their funding costs compared with those of euro area banks with an IG rating. All in all, the assumption that the already observed reduction of Greek banks' yields will be permanent seems plausible.

4.2 THE GENERAL EQUILIBRIUM EFFECTS OF A RATING UPGRADE

Methodology

This subsection provides a quantitative and qualitative assessment of the effects of a sovereign credit rating upgrade to investment grade in the context of a dynamic stochastic general equilibrium (DSGE) model. The model has a fully developed micro-founded private sector, as well as a detailed financial sector featuring bank intermediation, banking capital regulations and multiple agency problems, including household, firm and bank default in equilibrium.[15] It is, thus, rich in terms of the interactions between the real and financial sectors, and suitable for examining the transmission channels at play following a positive shock, such as an IG upgrade.

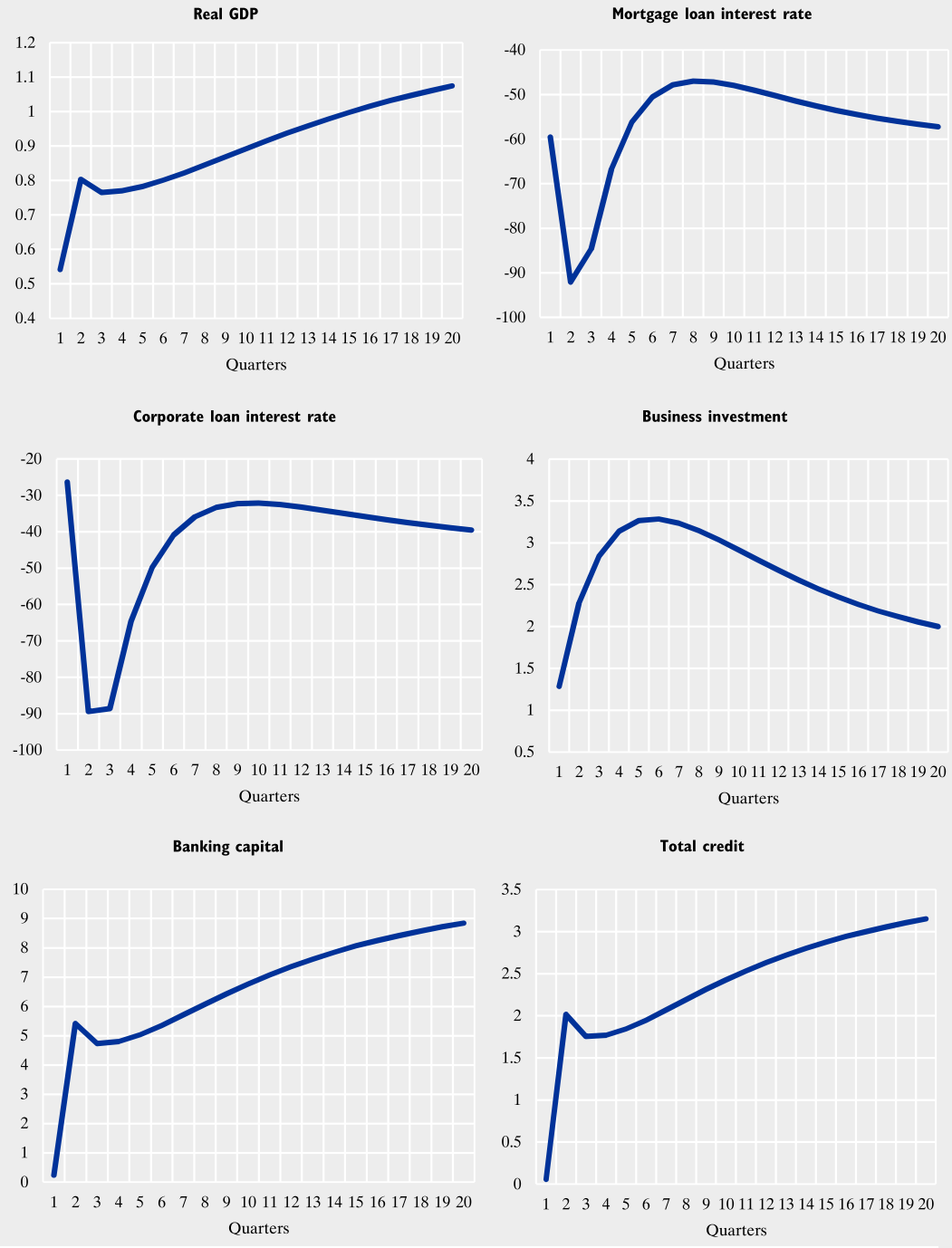
The approach adopted is as follows: First, the model is calibrated at a quarterly frequency to capture the key characteristics of the real and financial sectors of the Greek economy.[16] Then, drawing on the results of subsection 4.1, we simulate a rating upgrade shock as a permanent reduction in the bank funding costs by 100 basis points and report the dynamic responses of key real and financial variables. Additionally, we perform counterfactual experiments to examine whether a rating upgrade insulates the economy against exogenous shocks and prevents excessive volatility in the real and financial sectors of the economy. To this aim, we compare the dynamic responses following an exogenous shock in the benchmark calibrated economy (pre-rating upgrade economy) to those in an economy with lower funding costs (post-rating upgrade economy).

Dynamic responses to a rating upgrade shock

Chart 5 shows the dynamic responses of key financial and real variables to a rating upgrade shock over the first 20 quarters following the shock. The shock is transmitted from the financial sector to the real economy via the funding and bank capital channels. First, a rating upgrade reduces banks' funding costs, thus allowing them to reduce the lending rates they charge for mortgage and corporate loans and to increase credit supply (bank funding channel). In turn, households and firms increase their demand for investment and consumption, thereby prompting a rise in the prices of housing and physical capital. Given that, in the model, these assets constitute collateral against

15 For a detailed description of the model, see Clerc et al. (2015).
16 The calibration procedure for the Greek economy follows the work of Balfoussia and Papageorgiou (2016) and Balfoussia et al. (2019).

Chart 5 Dynamic responses to a rating upgrade shock



Source: Authors' own estimations.
Note: All variables are expressed as percentage deviations from the initial steady state, except for the (annualised) lending rates, which are expressed in changes in basis points.

Table 4 Long-run effects of a rating upgrade shock

Quarters	1	4	8	12	20	Long-run
Real GDP	0.54	0.77	0.85	0.94	1.10	1.30
Business investment	1.28	3.14	3.15	2.67	1.95	1.60
Housing investment	0.67	1.78	2.61	3.37	4.28	3.15
Banking capital	0.24	4.80	6.10	7.36	9.00	11.10
Total credit	0.06	1.77	2.19	2.63	3.15	4.16

Source: Authors' own estimations.
Note: All variables are expressed as percentage deviations from the initial steady state.

which loans have been pledged, this increase in asset prices leads to reduced rates of default for both mortgages and business loans. As a result, bank equity also increases, and, thus, so does the supply of loans, boosting economic activity (bank capital channel). Moreover, the average default of banks decreases and further reduces deposit funding costs and lending rates. It is notable that lending rates fall by less than the initial decline in banks' funding costs, resulting in higher bank profitability and net worth. Consequently, there is a second-round increase in asset prices, which also lowers default rates among borrowers and increases credit supply. This, in turn, further boosts economic activity.

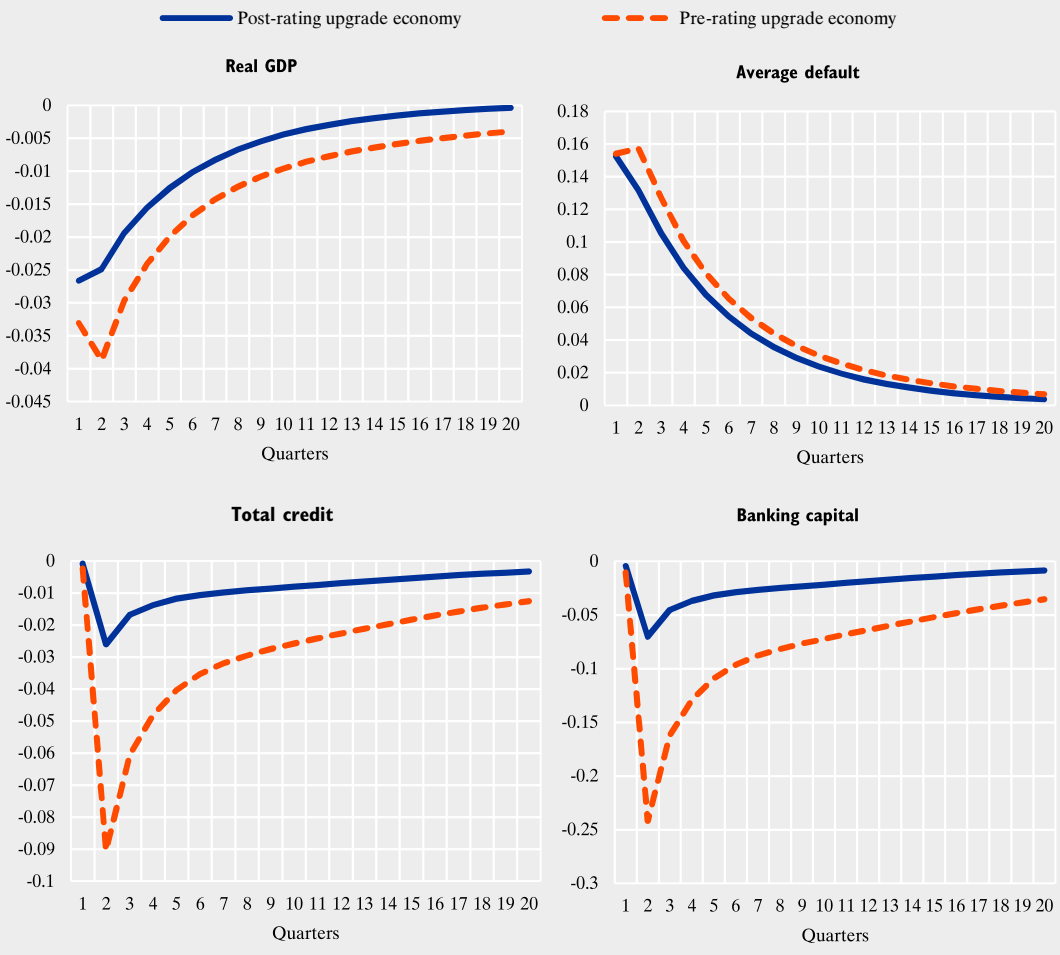
Table 4 summarises the main quantitative results of the rating upgrade shock. The level of real GDP increases by 0.94% after 12 quarters (3 years) following the shock. This translates into an average contribution to the real GDP growth rate of around 0.31 pps per year over the first 3 years after the upgrade. The levels of real business and housing investment increase by 2.67% and 3.37%, respectively, over the first 12 quarters. The levels of total credit and banking capital increase by 2.63% and 7.36%, respectively, over the same period.

As the positive shock of an IG upgrade is assumed to be permanent, it causes the economy to gradually move to a new steady-state equilibrium, i.e. it has permanent long-run effects. In the new long-run equilibrium, the levels of real GDP, business investment and housing investment increase by 1.3%, 1.6% and 3.15%, respectively. Total credit supply and banking capital increase by 4.6% and 11.1%, respectively. It should be noted that the total impact of an IG upgrade on the Greek economy could be even higher, as positive effects may also come about through other channels not incorporated in this analysis, for example via improved consumer confidence and increased FDI flows, *inter alia*.

Resilience gains from a rating upgrade to investment grade

In this section, we use the model to perform counterfactual experiments to examine whether a rating upgrade of the Greek economy would insulate it against exogenous shocks and prevent excessive volatility in the real and financial sectors of the economy. Chart 6 shows one such experiment, namely the dynamic responses to a one standard deviation negative bank risk shock in the benchmark calibrated economy (pre-rating upgrade economy) and in an economy with lower funding costs (post-rating upgrade economy). As can be seen, in the economy which enjoys lower funding costs due to the IG upgrade, there is a shorter and milder contraction of output compared to the benchmark economy. This reflects the fact that the shock has a smaller impact on banking capital and the default rate of banks, thus resulting in a much lower fall in credit supply. Similar results are obtained when we examine alternative exogenous shocks. In conclusion,

Chart 6 Effects of a bank risk shock



Source: Authors' own estimations.
Note: All variables are expressed as percentage deviations from the initial steady state, except for the average default, which is expressed in percentage point changes.

our counterfactual experiments indicate that a sovereign credit rating upgrade to investment grade strengthens the resilience of the real and financial sectors of the economy and prevents excessive volatility caused by exogenous shocks.

5 CONCLUSIONS

In conclusion, we employ a battery of approaches to explore the implications of a sovereign credit rating upgrade to investment grade for the Greek economy. Drawing on cross-country data, we provide empirical evidence that an upgrade is likely to be associated with a permanent reduction in the sovereign spread and a rise in the stock market. It is estimated that government bond yields decline by about 70 bps in connection to an upgrade to investment grade. These gains are expected to pass through to the cost of funding of Greek banks, both directly and indirectly, allowing Greece's further convergence to the euro area average. Moreover, based on previous cases of sovereign upgrades to investment grade, we

find that real GDP is expected to rise by up to 2.5% in the long run. Additionally, we employ a DSGE model of the Greek economy with a rich financial sector to examine the transmission channels at play following an upgrade. We study the dynamic responses of key real and financial variables and find that an upgrade has permanent positive effects, as the economy moves to a new steady state. Finally, counterfactual experiments illustrate that a sovereign credit rating upgrade to investment grade has a stabilising impact on both the banking sector and the real economy. It follows that there is a need for sound fiscal policies and reforms, which will help maintain the current investment grade rating and hopefully achieve further credit rating upgrades that could yield additional potential gains for the Greek economy.

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TECHNICAL APPENDIX

COMPONENTS OF SOVEREIGN BOND YIELDS

In the literature on the term structure of interest rates, the relationship between the nominal yield of a bond and the expected interest rates for the period spanning the term to maturity of the bond is given as follows:

$$y_t(\tau) = \frac{1}{\tau}\int_0^{\tau} f_t(u)du \qquad \text{(A.1)}$$

In equation (A.1), y_t is the yield of a zero-coupon bond with a term to maturity of τ years, and f_t stands for the forward rate. The integral, spanning the period until the maturity of the zero-coupon bond discounted for the number of years (i.e. $^1_\tau$), simply denotes that the nominal bond yield is the average of forward rates. So, in the absence of credit risk, this relationship associates the observed bond yield, after isolating pricing factors such as coupon payments or accrued interest, to the market's expectations about interest rates for each year up until the year in which the bond will mature. This equation will provide the (average) sensitivity of nominal bond yields, across the yield curves, to the (average) expected forward rates for the term to maturity of the bond. The most prominent way to fit the equation in the data is using the Nelson-Siegel yield curve model in the forward rates:

$$f_t(\tau) = \beta_1 + \beta_2 e^{-\lambda\tau} + \beta_3 \lambda e^{-\lambda\tau} \qquad \text{(A.2)}$$

which fits the yield curve model to the observed yields, per maturity segment, based on three latent factors (β_1, β_2 and β_3) and a limiting parameter (λ). Nevertheless, the affine term structure literature has been documented (Duffee 2002) to fail in efficiently forecasting zero-coupon risk-free bond yields, and the estimation of the above equation in the standard setup will leave a large deterministic residual. The residual will be the (average) term premia, reflecting factors such as uncertainty about future monetary policy and market liquidity.

Again, however, Duffee (2002) argues that the risk compensation cannot be independent from interest rate volatility, a condition inducing some kind of dynamics in the latent factor model of the yield curve. At this point, Diebold and Li (2006) argue that the extant, at the time, models of the term structure of interest rates inadequately forecast bond yields out of sample. On this basis, they introduced the dynamic-factor model shown below:

$$f_t(\tau) = \beta_{1t} + \beta_{2t} e^{-\lambda_t\tau} + \beta_{3t}\lambda_t e^{-\lambda_t\tau} \qquad \text{(A.3)}$$

which then provides the solution of the yield curve, based on three dynamic factors (i.e. β_{1t}, β_{2t} and β_{3t}) and a decay parameter (λ_t):

$$y_t(\tau) = \beta_{1t} + \beta_{2t}\left(\frac{1-e^{-\lambda_t\tau}}{\lambda_t\tau}\right) + \beta_{3t}\left(\frac{1-e^{-\lambda_t\tau}}{\lambda_t\tau} - e^{-\lambda_t\tau}\right) \qquad \text{(A.4)}$$

So, first we make use of the model above to capture the dynamic factors of the yield curve from risk-free zero-coupon bond yields and forward rates. Thus, on the one hand, equation (A.4) provides the *expectations parameter* of bond yields, i.e. their component which is associated to the expected short-term rates for the period until the maturity of each bond. On the other hand, the difference between the implied nominal bond yield $y_t(\tau)$ and the implied forward rate for the same maturity segment [i.e. $f_t(\tau)$] provides the measure of the premium for risks *à la* Duffee (2002). Since, until now, we work with AAA-rated bonds only, this premium cannot be explained by credit risk. In fact, previous studies (see, among others, Cochrane and Piazzesi 2005 and Adrian et al. 2013) associate it to higher uncertainty over future short-term rates, market liquidity etc., along higher terms to maturity; thus, this parameter captures the *term premium* of bond yields.

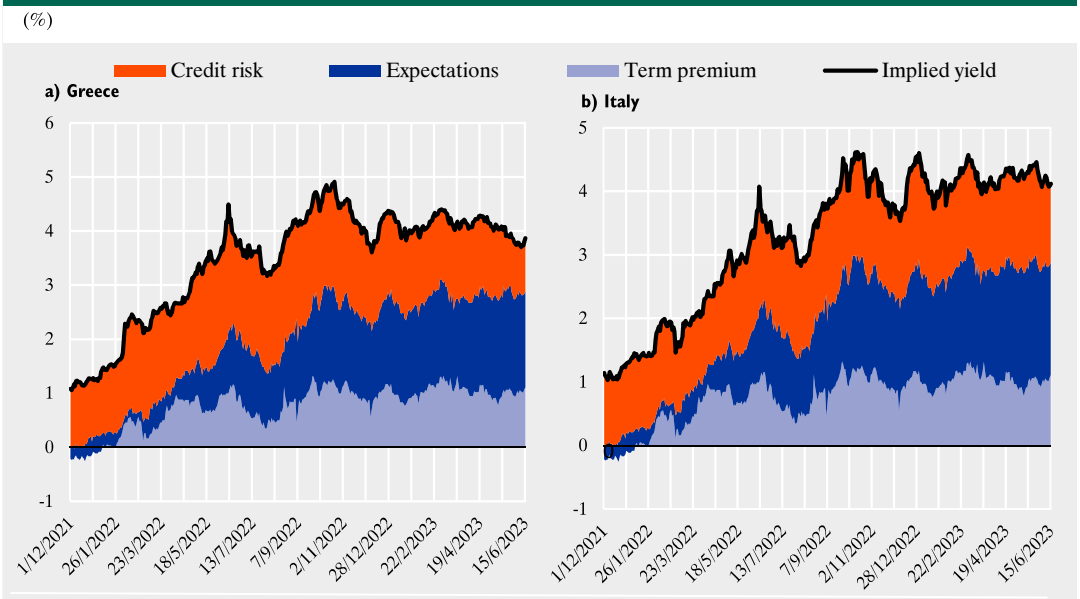
Now, employing the same model for defaultable bonds complicates things, with regard to the decoupling of the expectations parameter from the parameter that is associated with risks, as the origins of the latter could not be straightforwardly associated with the uncertainty over the level of short-term rates in the future. It would also reflect views about the level of credit risk of the underlying sovereign bond issuer. However, studies on the pricing of sovereign risk in bond markets associate the level of the credit risk premium in sovereign bond yields to the sovereign credit ratings (e.g. El-Shaggi and von Schweinitz 2018). In this strand of the literature, Malliaropulos and Migiakis (2018) associate bond yields to expected short-term rates and credit risk, as follows:

$$y_t^d(\tau) - y_t(\tau) = E_t\left[e^{\frac{1}{n}\int_0^\tau r_0(u)du} \cdot \left(e^{\frac{1}{n}\int_0^\tau (s(u)+x(u))du} - 1\right)\right] \quad \text{(A.5)}$$

where $y_t^d(\tau)$ is the yield of the defaultable bond (and $y_t(\tau)$ that of the risk-free one), E_t is the expectations operator for the information set available until time t, r_0 is the base rate (set by the central bank), s is the default risk premium and x is the currency risk premium. Now, the function $\int_0^\tau r_0(u)du$ can be shown to be equivalent to $\int_0^\tau f_\tau(u)du$, from equation (A.1), with the addition of a term premium.

At the same time, if the sovereign under examination has the same monetary policy authority with another one, as is the case for euro area sovereigns, then the expectations about short-term rates, i.e. the parameter $E_t\left(e^{\frac{1}{n}\int_0^\tau r_0(u)du}\right)$ in equation (A.5), should be uniform for both, say, Greek and Italian sovereign bonds. Additionally, in this case, equation (A.5) is simplified, as there is no currency risk premium. So, for euro area countries, this model decomposes sovereign bond yields into the parameters measured by the yield curve models for default-free bonds (i.e. the *expectations component* and the *term premium*) with the addition of a component reflecting *credit risk*. Chart A1 illustrates these components for Greek and Italian sovereign bonds with a ten-year term to maturity:

Chart A1 Components of ten-year sovereign bond yields



Source: Bank of Greece (econometric model).

Chart A1 shows that the differences in sovereign bond yields between Greece and Italy originate from the different level of the credit risk premium. Finally, again following Malliaropulos and Migiakis (2018), credit risk premia are linked to sovereign credit ratings; as a result, the movements of the differential of the credit risk components of Greece vis-à-vis Italy should mainly reflect market views about potential upcoming changes in the gap between the credit ratings of the two countries. Interestingly, as shown in panel (a) of Chart 3 in the main text, the differential of the credit risk components turned negative at around the time when S&P changed the outlook of the sovereign credit rating it assigned to Greece to positive, on 21 April 2023.