Insights on the Greek economy from the 3D macro model

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Abstract

The DSGE model of Clerc et al. (2015) is calibrated to data on the Greek economy and the dynamic responses to selected financial shocks which may have played a material role in the unfolding of the Greek crisis are explored. The results indicate *inter alia* that an increase in the depositors' cost of bank default leads to a substantial increase in the deposit rate, a decline in deposits and bank equity and an increase in bank fragility, while on the real side of the economy the decline in total credit prompts a deterioration of key macro variables. Additionally, the results imply that while recapitalizations increase bank net worth and credit supply and boost economic activity, this potential benefit is severely compromised in a high financial distress scenario, as the positive real and financial implications of a recapitalization become both smaller and more short-lived.

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1. Introduction

We examine the macroeconomic and welfare implications of banking capital requirement policies and their interactions with real and financial shocks for the Greek economy. In doing so, we adopt the Dynamic Stochastic General Equilibrium (DSGE) model of Clerc et al. (2015), that features a detailed financial sector, banking capital regulations and strategic defaults in equilibrium for three sectors of the economy, namely households, entrepreneurs and banks. The approach of this paper can be summarized as follows. First, we calibrate the model to the Greek economy to match certain features of the data. Then, we examine the long-run effects of different banking capital requirements on key model variables, including social welfare, and explore the long-run implications of different depositor costs of bank default. Finally, we study the dynamic responses to a number of financial shocks related to the recent Greek experience and explore their transmission mechanisms and interactions with banking capital regulations.

As the linkages between financial and macroeconomic stability are at the forefront of academic attention, there is a growing literature that attempts to incorporate banking sector and financial frictions in DSGE models (see e.g. Curdia and Woodford 2010, Gertler and Kiyotaki 2010, and Gerali et al. 2010). The model of Clerc et al. (2015) is one of the most innovative in this area.

Turning to the academic literature on the Greek economy, Papageorgiou (2012, 2014) and Papageorgiou and Vourvachaki (2016) are the most recent papers to use DSGE models calibrated to the Greek economy. However, to our knowledge, the links between the Greek financial sector and the macroeconomy have not, to date, been rigorously modelled, partly because prior to the recent crisis they were not of particular interest.

In applying the Clerc et al. (2015) model, our main interest is not to study or justify the use of macroprudential policies *per se* –as was their primary goal– but rather to explore how the mechanics of default may have operated in the case of Greece and their interplay with selected policy tools and risk shocks which are particularly relevant to the Greek crisis experience. As some of these have not, to date, been considered in the 3D context, the present paper is not only a country

study, but also an effort to provide some further insights regarding the linkages between macroprudential policies, financial shocks and the real economy.

In the aftermath of the global financial crisis, the Greek economy is an inherently interesting case study. The crisis brought to the surface the underlying fragility of an over-indebted country with limited policy options and prompted a domino effect on all sectors of the economy. Government spreads skyrocketed and as a result the Greek banking sector was cut off from the interbank market, in a sharp and protracted liquidity squeeze. Many small banks, faced with the spectre of default, were forced to merge with larger ones. The banking system as a whole was recapitalized several times, in an effort to render it viable and to allow it to resume its role as a mediator between savers and investors. Nonetheless, credit flows continued to decline sharply, as the Greek economy entered into a deep recession which drove many businesses out of the market and a significant part of the labour force into unemployment. As a result, non-performing loans accumulated, causing a vicious circle which, in the absence of access to the interbank market, implied further declines in credit flows and the need for further bank recapitalisation. In sum, in the Greek case, all sectors that are allowed to default in the 3D model faced substantial shocks, which effectively led to defaults over the course of the crisis. Furthermore, the impact of poor macroeconomic performance on financial intermediation was substantial, as was the feedback effect of disrupted financial intermediation on the macroeconomy.

Our main results are the following. The relationship between the bank capital requirement ratio and social welfare is hump-shaped, implying an optimal level of capital requirements. Additionally, we explore the implications of applying haircuts to depositors in the case of bank defaults, a scenario which was considered likely during the Greek crisis, and find that both the real and financial repercussions are negative. Finally, in view of the repeated recapitalisations of Greek banks in recent years, we explore the effects of such a positive shock to the banking sector and find that although recapitalizations can indeed have a positive impact on both real and financial variables, these benefits become both smaller and more short-lived under financial distress.

The remainder of the paper is structured as follows: Section 2 presents the steady-state analysis, illustrating the dynamic effects of different levels of capital requirements and the depositor cost of bank default. Section 3 presents an impulse response analysis and relates it to the recent Greek experience. Finally, Section 4 concludes.

2. Steady-state analysis

2.1 The calibration of the model and the long-run solution

We first calibrate the model for the Greek economy to match certain features of the data.[1] Tables 1 and 2 report the calibrated parameters and the long-run solution. Details for the calibration can be found in Balfoussia and Papageorgiou (2016). Using as a starting point the implied long-run solution, we consider the steady-state effects of changes in: i) the capital requirement ratio and ii) the depositor cost of bank default.

[1] Details for the model can be found in Clerc et al. (2015).

Table 1. Calibrated parameters

Description	Parameter	Value
Patient Household Discount Factor	β^s	0.992
Impatient Household Discount Factor	β^m	0.98
Patient Household Utility Weight of Housing	υ^m	0.25
Impatient Household Utility Weight of Housing	υ^s	0.25
Patient Household Marginal Disutility of Labor	φ^s	1
Impatient Household Marginal Disutility of Labor	φ^m	1
Inverse of Frisch Elasticity of Labor	η	0.2
Depositor Cost of Bank Default	γ	0.242
Variance of Household Idiosyncratic Shocks	σ_m^2	0.1
Household Bankruptcy Cost	μ^m	0.3
Dividend Payout of Entrepreneurs	χ^e	0.06
Variance of Entrepreneurial Risk Shock	σ_e^2	0.5
Entrepreneur Bankruptcy Cost	μ^e	0.3
Capital Requirement for Mortgage Loans	$\overline{\phi}^H$	0.04
Capital Requirement for Corporate Loans	$\overline{\phi}^F$	0.08
Mortgage Bank Bankruptcy Cost	μ^H	0.3
Corporate Bank Bankruptcy Cost	μ^F	0.3
Capital Share in Production	α	0.4
Capital Depreciation Rate	δ	0.025
Capital Adjustment Cost Parameter	ξ^K	2
Housing Depreciation Rate	δ^H	0.015
Housing Adjustment Cost Parameter	ξ^H	2
Shocks Persistence	ρ	0.9
Dividend Payout of Bankers	χ^b	0.06
Variance of Mortgage Bank Risk Shock	σ_H^2	0.01669
Variance of Corporate Bank Risk Shock	σ_F^2	0.0339

Table 2. Long-run solution

Description	Data averages	Long run solution
Total consumption over GDP	0.64	0.5426
Investment (related to the capital good production) /over GDP	0.145	0.1386
Investment in housing/over GDP	0.084	0.0791
The premium required by the depositor in order to deposit his money in the risky bank	0.55	0.50
Borrowing spread for entrepreneurs	2.74	1.7243
Borrowing spread for households	1.25	0.8617
Debt of entrepreneurs over debt of households	1.226	1.2514
Debt-to-GDP ratio of entrepreneurs (annualized)	0.491	0.5031
Debt-to-GDP ratio of borrowers (annualized)	0.421	0.4021
Default rate - mortgages	-	0.34
Default rate - entrepreneurs	-	13.86
Default rate - firm lending banks	-	2.04
Default rate - mortgage lending banks	-	2.06

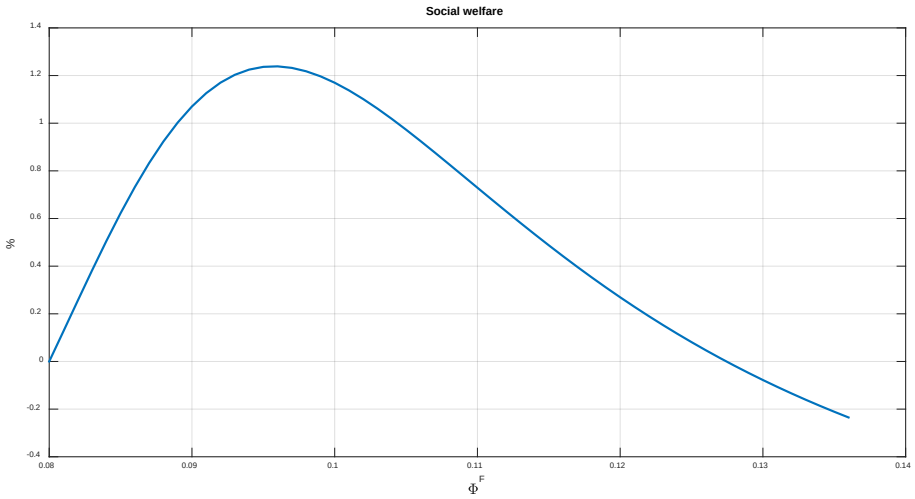
2.2 The steady-state effects of capital requirements

We first consider the long-run effects of capital requirements on key model variables and social welfare. Following e.g. Lucas (1990), the latter is calculated by computing the permanent consumption subsidy that is required in each period so as to make aggregate welfare under the baseline policy ($\phi^F = 0.08$ and $\phi^H = 0.04$) equal to the welfare under alternative values of ϕ^F and ϕ^H.

As depicted in Figure 1, the steady-state relationship between capital requirements and social welfare exhibits a humped shape similar to that of Clerc et al. (2015) for the Eurozone, implying a trade-off between capital requirements and welfare. On the one hand, higher capital requirements reduce the average default rate for banks triggering a reduction in deposit insurance costs and an increase in credit supply that improves economic activity. On the other hand, higher capital requirements reduce the supply of funds and that negatively affects economic

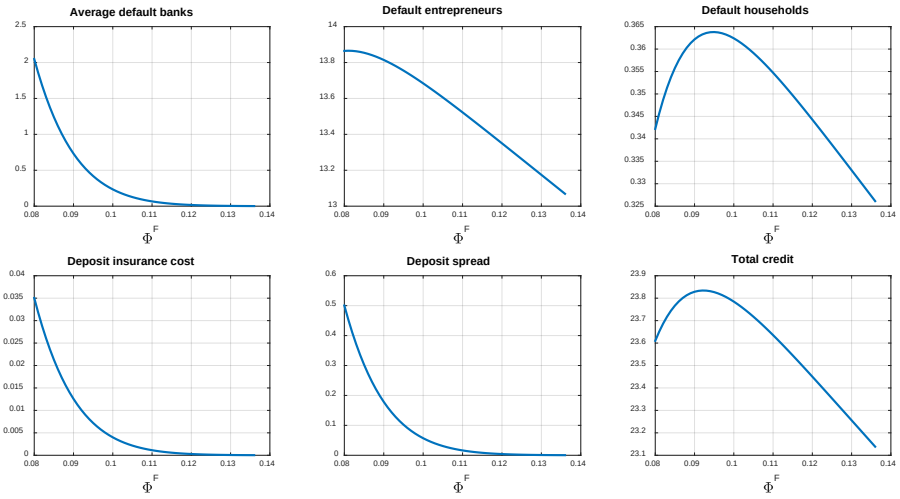
activity. The optimal capital requirement that maximizes welfare is around 9.6 for business loans (half of that for mortgages).

Figure 1. Steady-state welfare gains/losses depending on the capital requirement



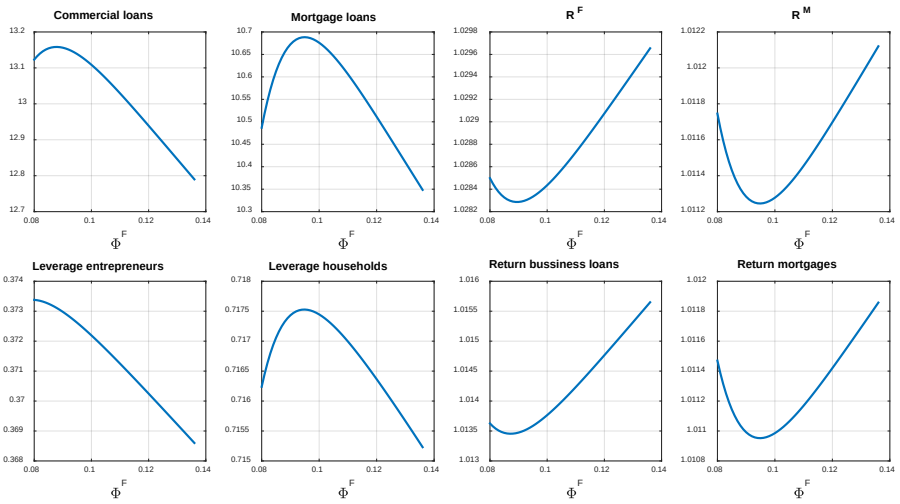
Figures 2 - 4 illustrate the implications of a change in ϕ^F and ϕ^H for the steady-state values of key variables in the model. Higher capital requirements imply by definition a lower average default rate of banks (Figure 2). This leads to a decline in the deposit insurance subsidy, thus freeing up resources in the economy. The deposit spread required by the saving households in order for them to deposit their savings in the banks also declines. Up to a point, the beneficial stabilizing effects of an increase in capital requirements lead to an increase in total credit and a boost in consumption and overall economic activity (Figures 3-4). However, for much higher levels of capital requirements, total credit begins to decline. Households and firms have access to less credit which is provided at higher interest rates. The negative real implications of the decline in credit supply dominate the positive impact of declining bank defaults.

Figure 2. Steady-state values depending on the capital requirement (I)



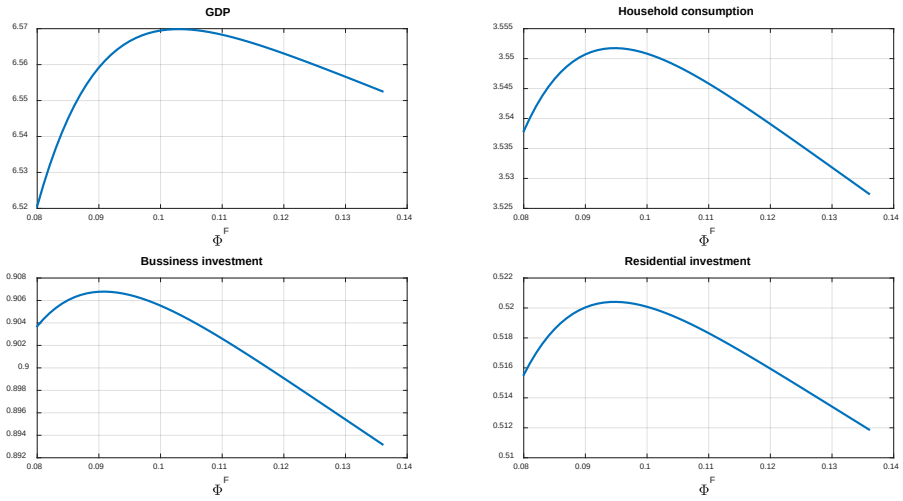
Note: Alternative policies involve the value of ϕ^F in the horizontal axis with $\phi^H = \phi^F / 2$

Figure 3. Steady-state values depending on the capital requirement (II)



Note: Alternative policies involve the value of ϕ^F in the horizontal axis with $\phi^H = \phi^F / 2$

Figure 4. Steady-state values depending on the capital requirement (III)



Note: Alternative policies involve the value of ϕ^F in the horizontal axis with $\phi^H = \phi^F / 2$

2.3 The steady-state effects of the depositor cost of bank default

We now explore the long-run effects of a variable which may have played a material role in the unfolding of the Greek crisis, namely the potential cost of a bank default on depositors. In the model, this cost takes the form of a direct haircut on households' deposits. At the peak of the crisis, Greek banks were perceived to be so fragile that depositors made huge deposit withdrawals, moving their cash savings either to some physical storage space or to overseas banks. The aim of this flight to safety was precisely to avoid a haircut of the type that was imposed on selected depositors in Cyprus, as well as to hedge against the possibility of Greece leaving the euro area, which was publicly discussed at the time. In order to gain a better understanding of this period, we consider the effects of higher depositor costs of bank default on the model's steady state. Figures 5-7 illustrate that, as a first order effect, an increase in the depositors' cost of bank default leads to a substantial increase in the deposit spread required by households in order to deposit their savings in the banks and a decline in deposits. This in turn leads to a decline in total credit and leverage, a decline in bank equity and an increase in bank defaults. As a result, all macro variables also clearly decline. This domino effect fits in well with the

Greek crisis experience, as indeed deposit withdrawals took a heavy toll on both the stability of the financial sector and real economic activity.

Figure 5. Steady-state values depending on depositor cost of bank default (I)

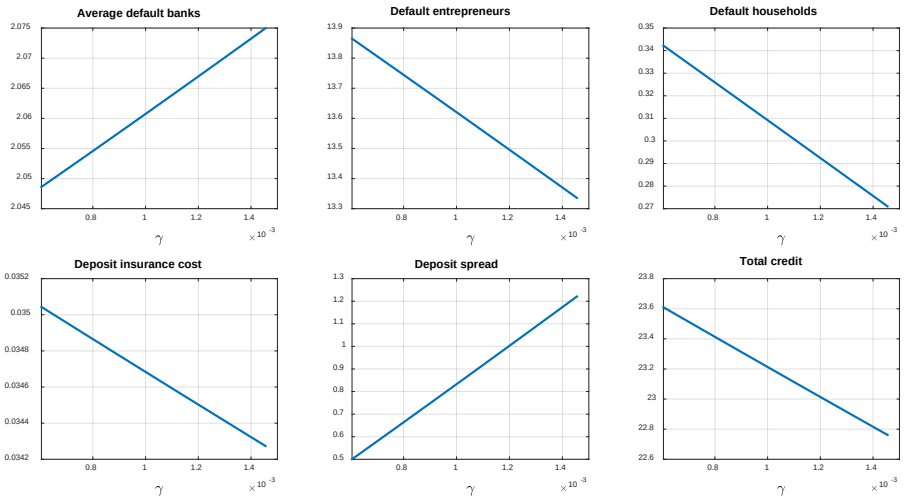


Figure 6. Steady-state values depending on depositor cost of bank default (II)

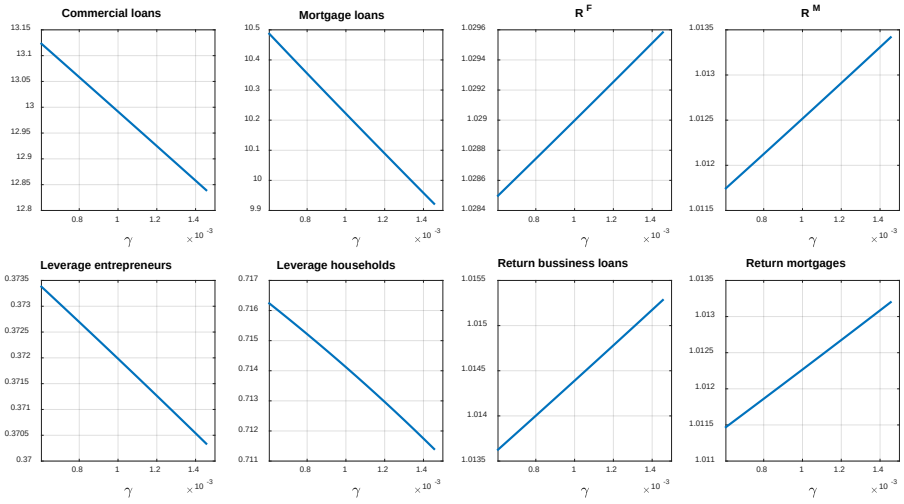
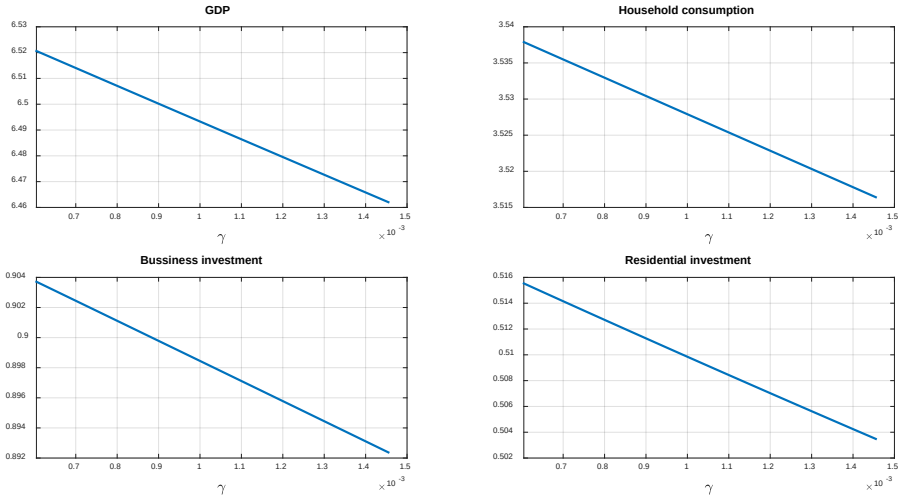


Figure 7. Steady-state values depending on depositor cost of bank default (III)



3. Impulse response analysis

We now examine the dynamic responses to various exogenous shocks under different parameterisations. In particular, we compare the benchmark economy with an economy with i) higher financial distress in the banking sector and ii) higher capital requirements.[2]

3.1 The dynamic effects of a shock to bankers' wealth

We first examine the dynamic effects of a temporary 1% increase in the bankers' wealth (Figures 8-11). This can be thought of as akin to an exogenously funded bank recapitalization. Greek banks were indeed recapitalized several times, with the aim to alleviate the possibility of bank defaults, stabilize the financial system and create the conditions for a recovery of credit flows to the real economy. We examine the dynamic effects of such a shock under high financial distress and under high capital requirements.

For the case of the baseline calibration, a positive shock to bankers' wealth is mapped into higher bank capital. As a result, there is an increase in total credit which

[2] For the case of high financial distress we set the volatility for bank-specific idiosyncratic risk shocks 30% higher than in the baseline calibration. For the case of higher capital requirements we set $\phi^F = 0.096$ and $\phi^H = \phi^F/2$.

has a positive effect on capital investment. The price of capital increases, implying lower default rates by entrepreneurs and thus an improvement in the banks' balance sheets. The decline in bank defaults also prompts a fall in the cost banks must pay to attract deposit funding. This passes through, lowering lending rates and further boosting total credit. These second order positive effects create a virtuous circle. The improved creditworthiness of the banking sector prompts an increase in deposits and a concurrent decline in consumption and housing investment, which are crowded out. The net effect on GDP is however clearly positive.

Figure 8. Dynamic effects of a positive shock to bankers' wealth - High financial distress (I)

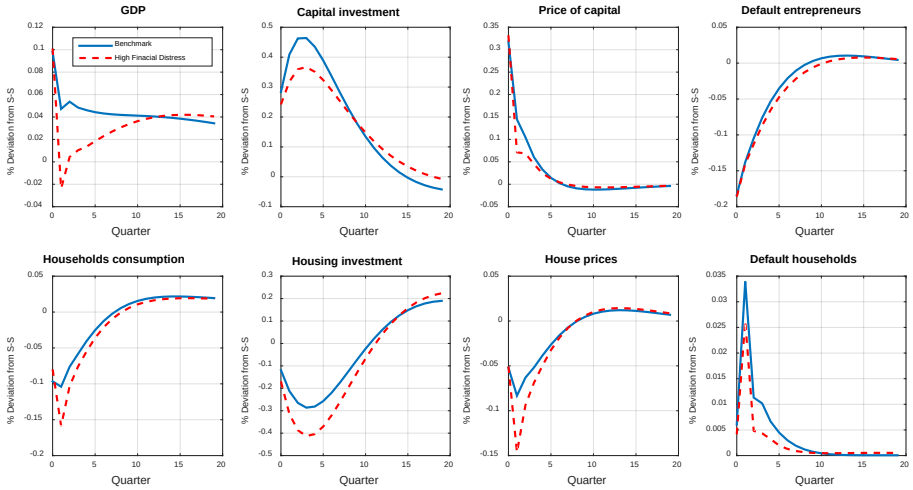
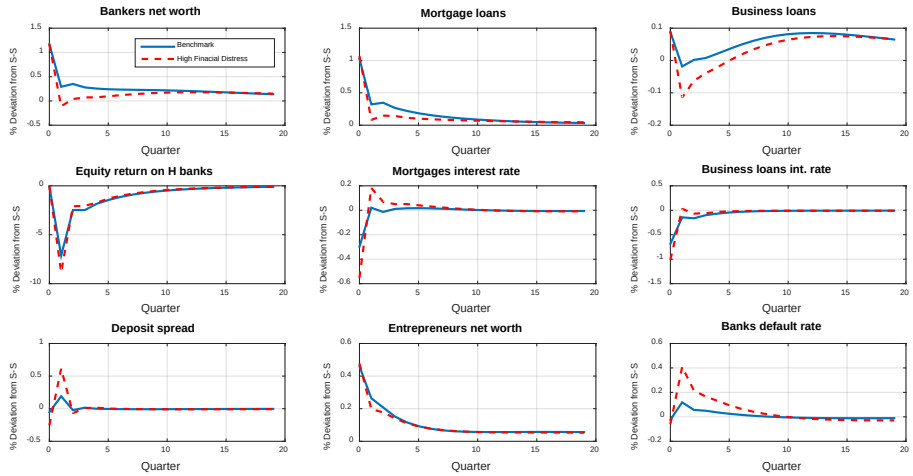


Figure 9. Dynamic effects of a positive shock to bankers' wealth - High financial distress (II)



We use a dashed line to plot the dynamic effect of the same temporary shock under high financial distress and under high capital requirements. We find that under high financial distress both the average rate of bank default and the deposit premium decline by much less. As a consequence, the positive real and financial impact of a recapitalization is smaller and more short-lived. Conversely, operating via the same channels, higher capital requirements accentuate the positive real impact of a bank recapitalization.

Figure 10. Dynamic effects of a positive shock to bankers' wealth - High capital requirements (I)

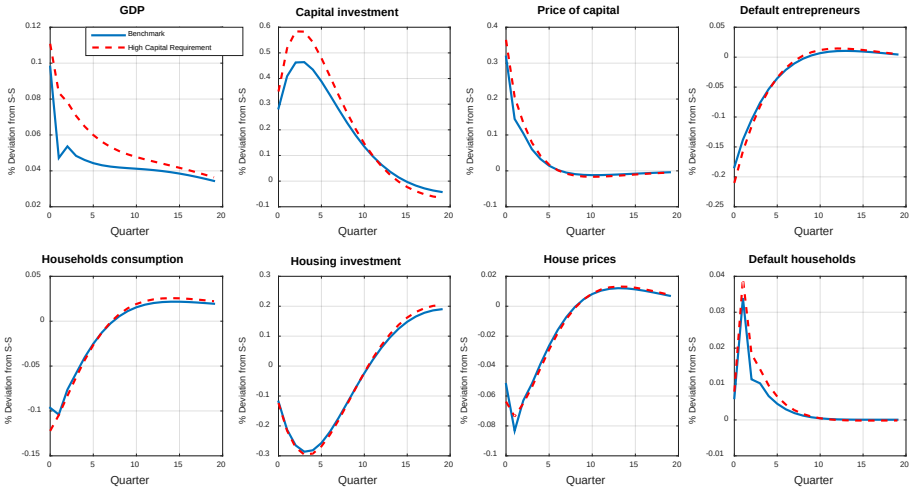
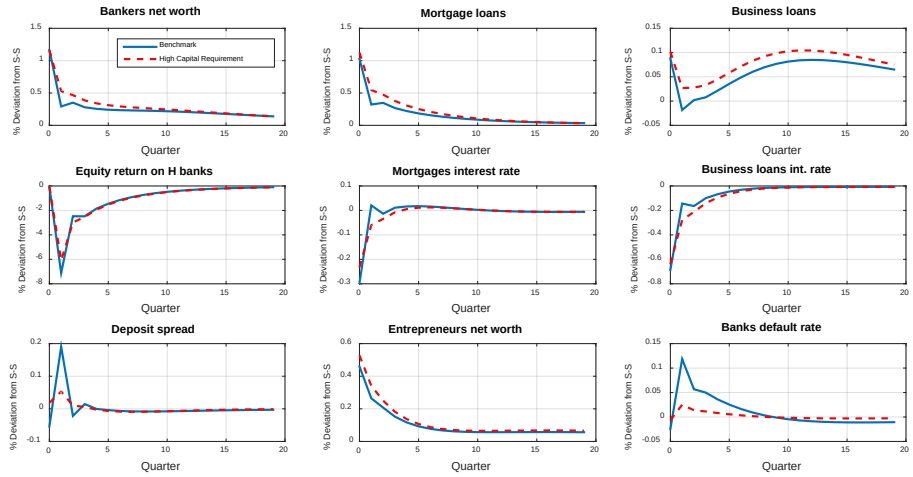


Figure 11 Dynamic effects of a positive shock to bankers' wealth - High capital requirements (II)



By analogy, a negative shock to bankers' wealth would mimic the impact of the sharp decline in banks' net worth recorded several times during the recent crisis in Greece. The resulting dynamic effects would provide insights into how this negative shock filtered through to the real economy.

3.2 The dynamic effects of risk shocks

The dynamic effects of a temporary 1% negative shock to the variance of idiosyncratic bank risk can be seen in Figures 12 and 13. The immediate effect is an increase in bank defaults. This is propagated via the net worth channel, depressing bankers' net worth and thus restricting total credit to the economy and reducing output through both consumption and investment. The bank funding cost channel also comes into play. The banks' cost of deposit funding increases, pushing lending rates up and further limiting the flow of credit to the real economy.

Figure 12. Dynamic effects of a bank risk shock (I)

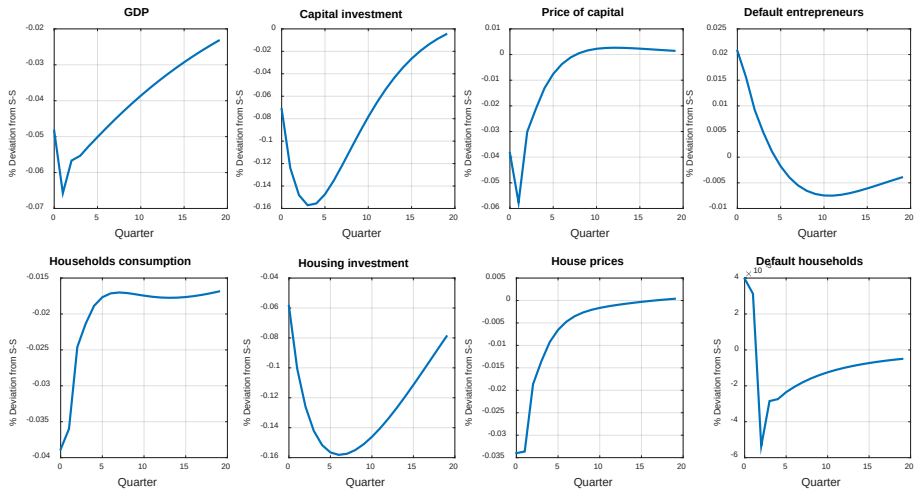
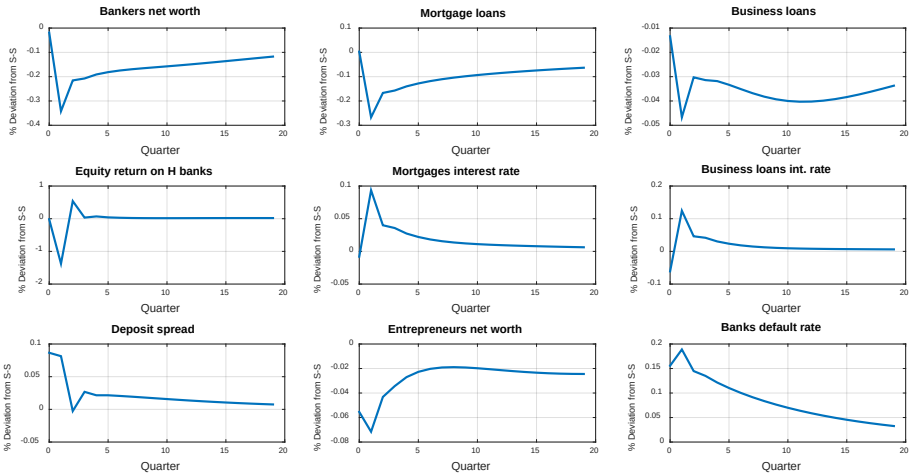


Figure 13. Dynamic effects of a bank risk shock (II)



The effects of an analogous negative 1% risk shock to all sectors in the economy, which is arguably what happened in Greece during the recent crisis, is depicted in Figures 14 and 15. Here the transmission of the shocks operate also through an increase in the rate of default of households and entrepreneurs, leading to a decline in capital investment and the price of capital, which negatively affects GDP. The higher default rate for households and corporations leads to a further increase in bank defaults, as it weakens their balance sheets. Credit supply declines as a result, prompting an additional decline in output and further household and corporate defaults. The cost of deposit funding faced by banks also leads to higher lending rates, further reducing the supply of credit.

Figure 14. Dynamic effects of a risk shock to all agents (I)

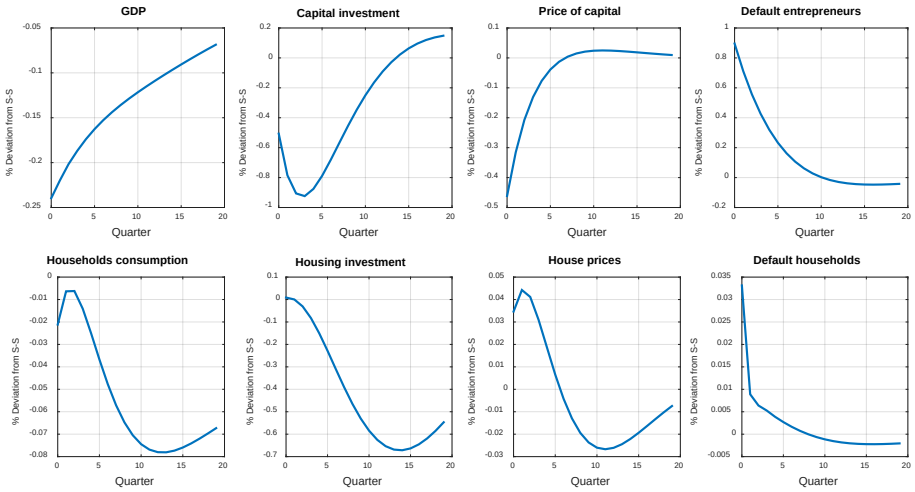
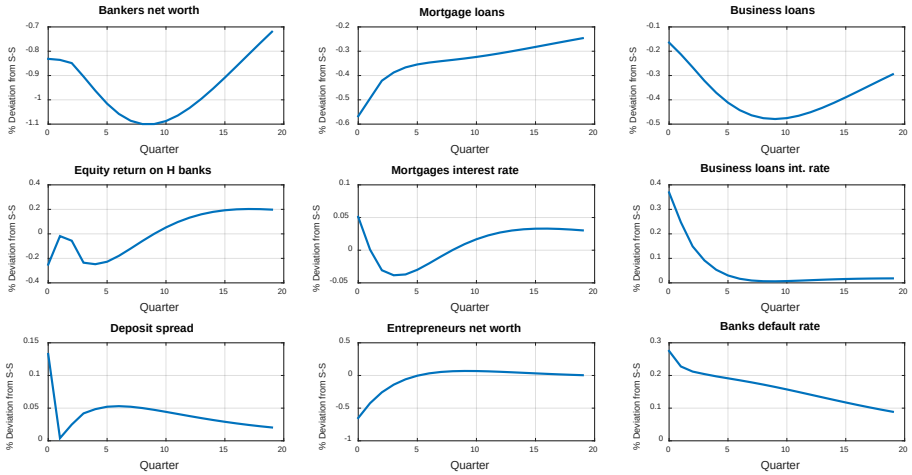


Figure 15. Dynamic effects of a risk shock to all agents (II)



4. Conclusion

In this paper we have examined the macroeconomic and welfare implications of banking capital requirement policies and their interactions with real and financial shocks for the Greek economy. We adopted the model of Clerc et al. (2015), a DSGE model that features a detailed financial sector, banking capital regulations and bank defaults. We calibrated the model to the Greek economy and examined the long-run effects of banking capital requirements on key model variables, as well as the dynamic responses to selected financial shocks which may have played a material role in the unfolding of the Greek crisis.

The results showed that bank capital requirements reduce bank leverage and the default risk of banks. The relationship between the bank capital requirement

ratio and social welfare is hump-shaped The optimal value of capital requirements for business loans in Greece if found to be around 9.6%. Moreover, in line with the recent Greek experience, we find that an increase in the depositors' cost of bank default leads to a substantial increase in the deposit premium, a decline in deposits and bank equity and an increase in bank fragility while, on the real side of the economy, the decline in total credit prompts a deterioration of key macro variables.

Finally, against the backdrop of the repeated recapitalisations of Greek banks in recent years, our results suggest that recapitalizations can indeed increase bank net worth and credit supply and thus boost economic activity. However, this potential benefit is severely compromised in a high financial distress scenario, as the positive real and financial implications of a bank recapitalization become both smaller and more short-lived. This is a novel and intuitive finding. Moreover it fits in well with recent experience in the Greek banking sector, where systemic banks had to be repeatedly recapitalized precisely because the gains from each recapitalization were quickly eroded within the highly uncertain financial environment which prevailed at the time.

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